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Salmon Creek Landscape Assessment

Kenai Peninsula Zone, Chugach National Forest

SALMON CREEK LANDSCAPE ASSESSMENT

2011

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Introduction

Purpose

A landscape assessment is a broad-level analysis to provide context and information regarding the effects and impacts that management decisions may have on the ecosystem. Its purpose is to guide land management decisions and provide a means of refining the desired conditions, management prescriptions, and standards and guidelines from the Chugach National Forest Land and Resource Management Plan (USDA Forest Service 2002a) and current policy and other applicable State and Federal regulations. A landscape assessment is an intermediate step between the Forest Plan and project planning, and serves as a basis for developing project-specific recommendations and determining restoration and monitoring needs within the analysis area.

The structure of this landscape assessment is based on "Ecosystem Analysis at the Analysis area Scale: A Federal Guide for Analysis area Analysis", a publication produced by a variety of agencies, governments, and organizations (Regional Interagency Executive Committee 1995). The analysis is driven by a set of issues and key questions for a specific analysis area. This type of analysis is not a decision-making process, but uses existing data and information to establish the context for project-specific decisions. This document is divided into the following eight sections:

1. Introduction
2. Analysis area Characterization
3. Key Issues and Questions
4. Current Conditions
5. Reference Conditions
6. Synthesis and Interpretation
7. Desired Condition, Opportunities, Management Strategies, Data Gaps, Monitoring and Research Needs
8. Recommendations

We discuss the following topics within each of these sections:

- Lands
- Geology, Minerals, and Soils
- Hydrology
- Vegetation and Ecology
- Botany and Weeds
- Fire and Fuels
- Aquatic Species and Habitats
- Terrestrial Species and Habitats
- Heritage Resources
- Recreation

The Analysis Area

The Salmon Creek Analysis area and Landscape Assessment area is approximately 61.693 acres located northwest of Seward, Alaska (Figure 1). .

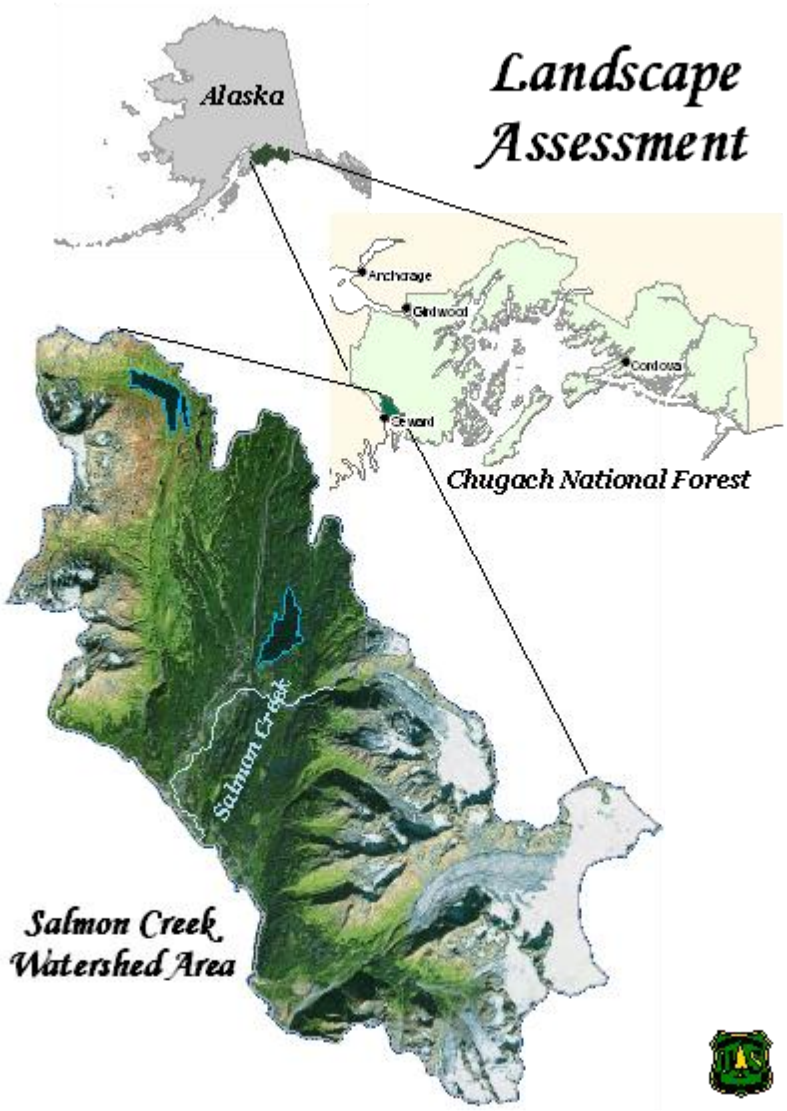


Figure 1. Location of the Salmon Creek Analysis area

The analysis area includes lands owned by the Chugach National Forest, State of Alaska, Kenai Peninsula Borough (2010), City of Seward and private land owners (see Figure 2). More than half the lands within the area (38,170 acres) are federal lands managed by the U.S. Forest Service, Chugach National Forest.

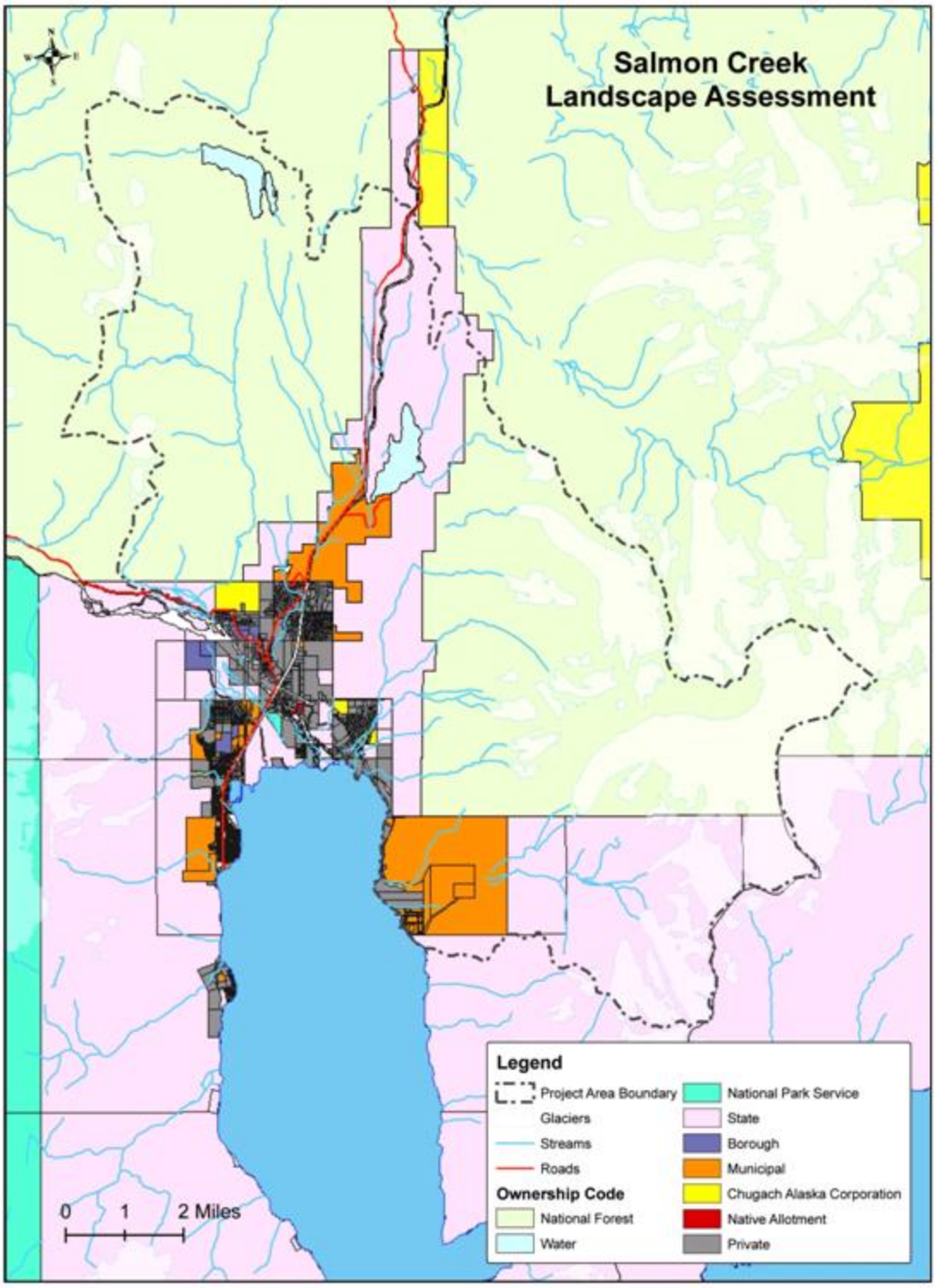


Figure 2. Location of different land owners within the Salmon Creek Analysis area

Management for Forest Service lands is directed by the Chugach National Forest land management prescriptions as stated in the Chugach National Forest Plan (USDA 2002a). Land management objectives

for this analysis area include 4 different management areas identified within the Chugach National Forest Revised Land and Resource Management Plan (See Table 1and Figure 3) including:

- Backcountry - managed to emphasize a variety of recreational opportunities for backcountry activities in natural appearing landscapes.
- Fish, Wildlife, & Recreation - managed to provide a variety of habitats for fish and wildlife species and year-round recreational opportunities in both developed and dispersed settings.
- Transportation/Utility Corridor- managed for existing and future transportation/utility systems.
- Wilderness Study Area- managed to maintain presently existing wilderness character and potential for inclusion in the National Wilderness Preservation System.

The remaining acres in the analysis area are non-national forest acres or water.

Table 1. Forest Plan Management Areas

Forest Plan Management Area	Acres
Backcountry Prescription	35,990
Fish, Wildlife & Recreation Prescription	2235
Transportation/Utility Corridor	6
Wilderness Study Area	10

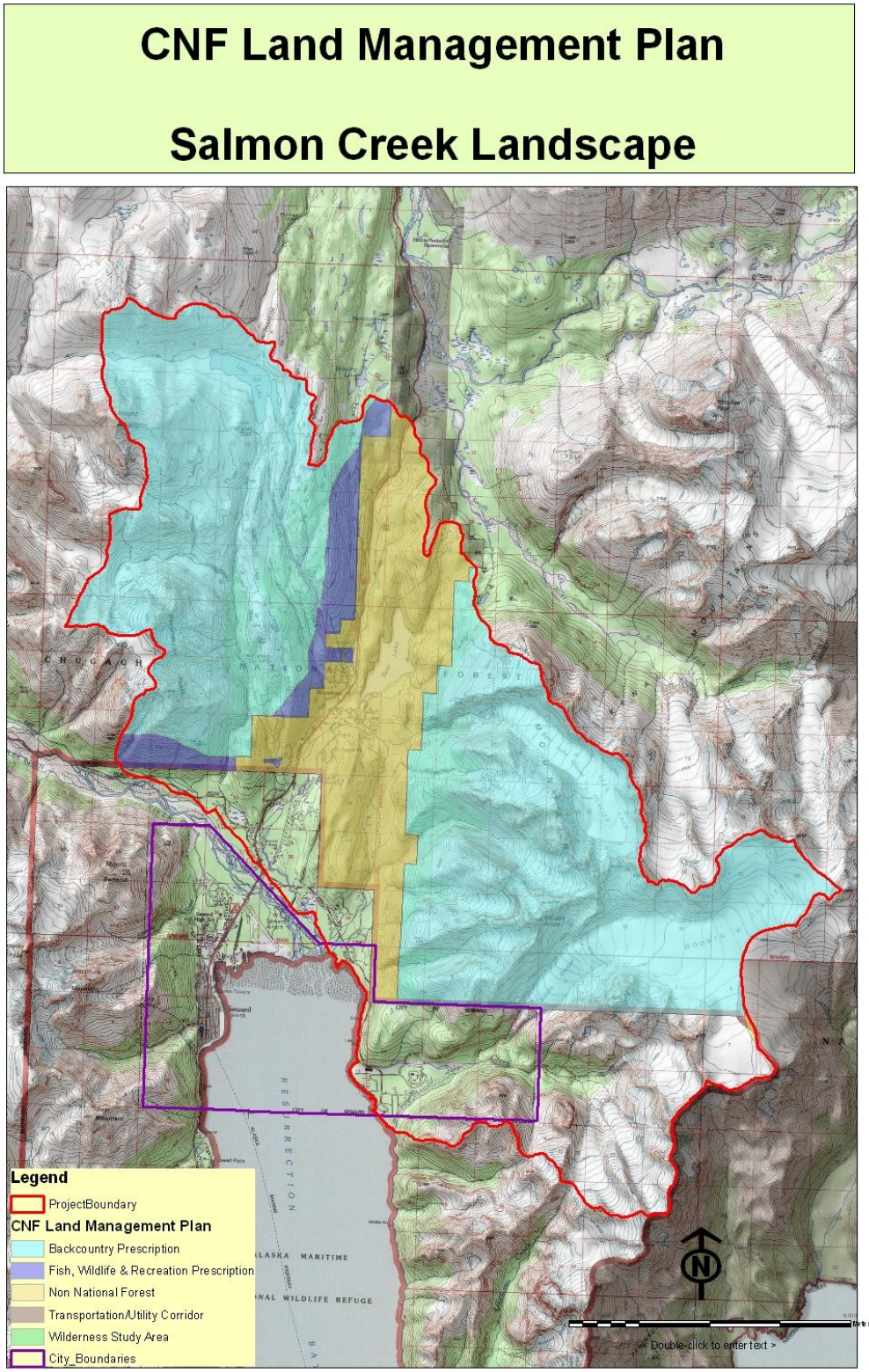


Figure 3. Land Management Plan Area

Analysis Area Characterization

Lands

The Salmon Creek landscape assessment area contains the City of Seward, public lands to the north and east, and a portion of the Resurrection Bay shoreline to the southeast. The area is characterized by steep mountains crowned by ice fields to the east and west.

Land Status Overview: More than half the lands within the project area (38,170 acres) are federal lands managed by the U.S. Forest Service, Chugach National Forest (See Figure 2). For the most part, National Forest System lands within the watershed are located in upland areas and not encumbered with easements, licenses, or other partial interests.

Ownership patterns of the uplands within the analysis area are displayed on the attached ownership map. Land status beneath waters of the project area has not yet been determined, though several property interests have been granted in waters of the project area. There are at least two congressionally designated features within the watershed.

Land Ownership: In addition to the roughly 38,000 acres managed by the Chugach National Forest, the State of Alaska, City of Seward, and other public entities have significant land holdings within the project area. The State of Alaska Department of Natural Resources manages 14,747 acres of state lands in the project area, the majority of which is located around the City of Seward and along either side of the Seward Highway. The City of Seward owns 2,416 acres in the project area, mostly situated on either side of the highway between Bear Lake and private lands to the south, and near the northeastern end of Resurrection Bay around Fourth of July Creek. Other major land owners include the Kenai Peninsula Borough (1,344 acres), Cook Inlet Region Inc. (265 acres), and Alaska Mental Health Trust Authority (235 acres). The remainder (about 3,340 acres) is a combination of privately owned, federal and state lands, and one Alaska Native allotment. Figures 3 and 4 depict land ownership patterns within the project area.

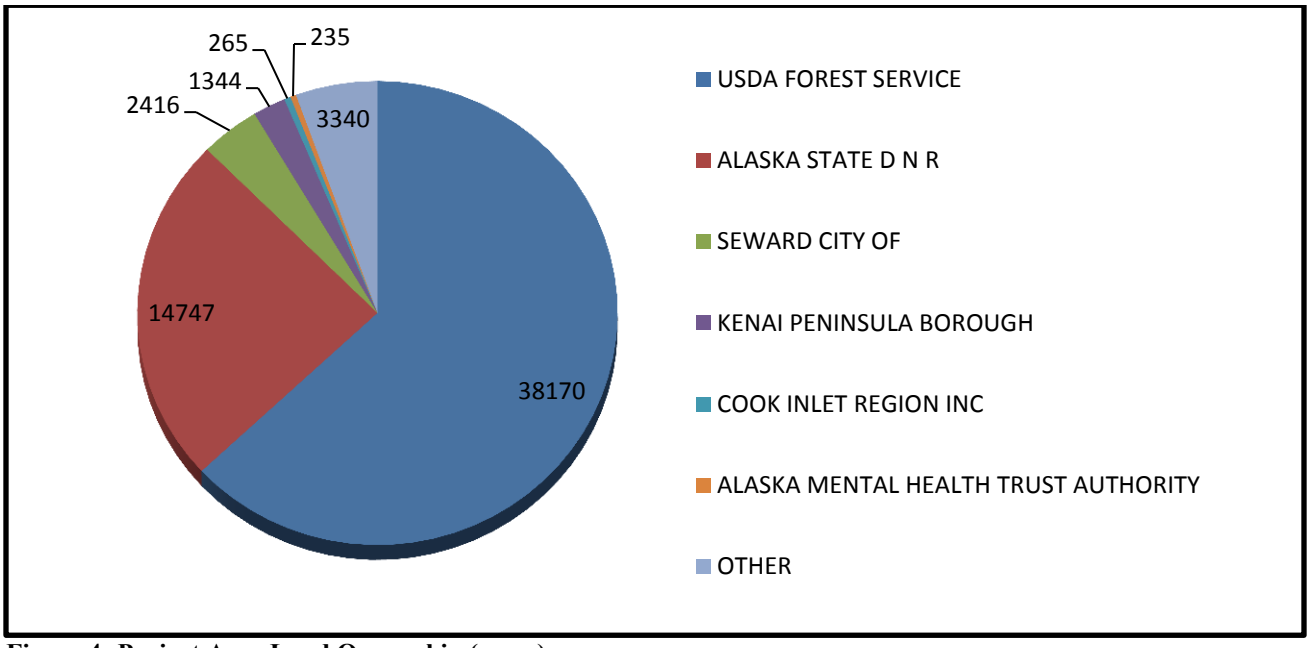


Figure 4: Project Area Land Ownership (acres)

Submerged Lands: Ownership of the lands beneath waters within the project area has not been established by the Bureau of Land Management (BLM). In Alaska, the BLM issues determinations of "navigability" for the purpose of determining title as between the United States and the State of Alaska to lands beneath navigable waters.[1] Records maintained by the Bureau of Land Management suggest that no navigability determinations have been made by BLM for waterways within the Salmon Creek Watershed project area.[2]

Water rights: The State of Alaska Department of Natural Resources has issued several water rights certificates for the use of ground and surface waters of the project area (refer to the Water Estate map at Figure 5 for specific locations). According to the map, no in stream reservations of water have been granted within the project area.

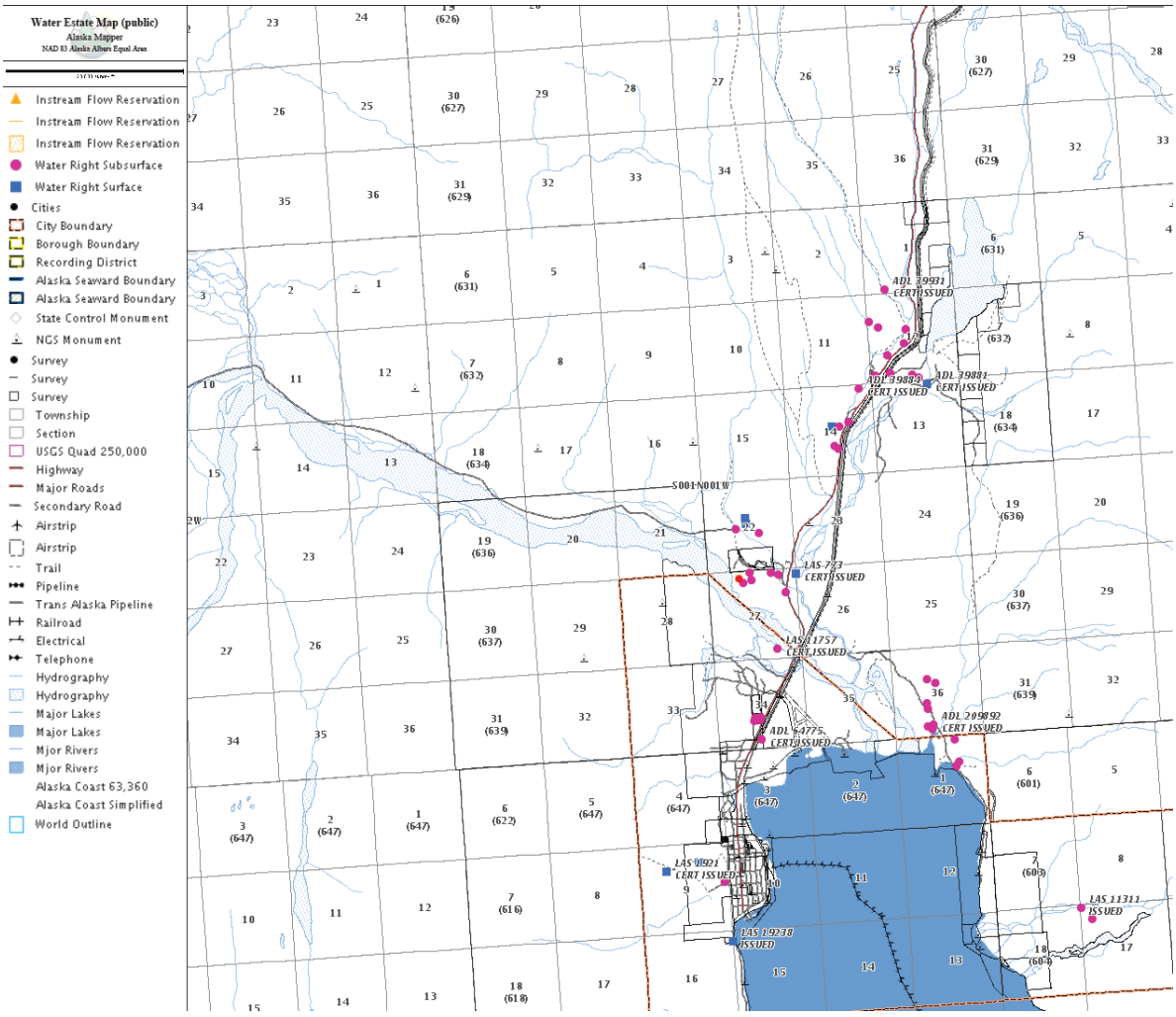


Figure 5. Water Estate Map

[1] U.S. Department of Interior. 2009. Manual of Surveying Instructions: For the Survey of the Public Lands of the United States. Bureau of Land Management. Denver, CO: Government Printing Office, at p. 26.
[2] Navigability determinations can be mapped using BLM's Spatial Data Management System, available at http://sdms.ak.blm.gov/isdms/imf.jsp?site=sdms (visited 4/18/2011).

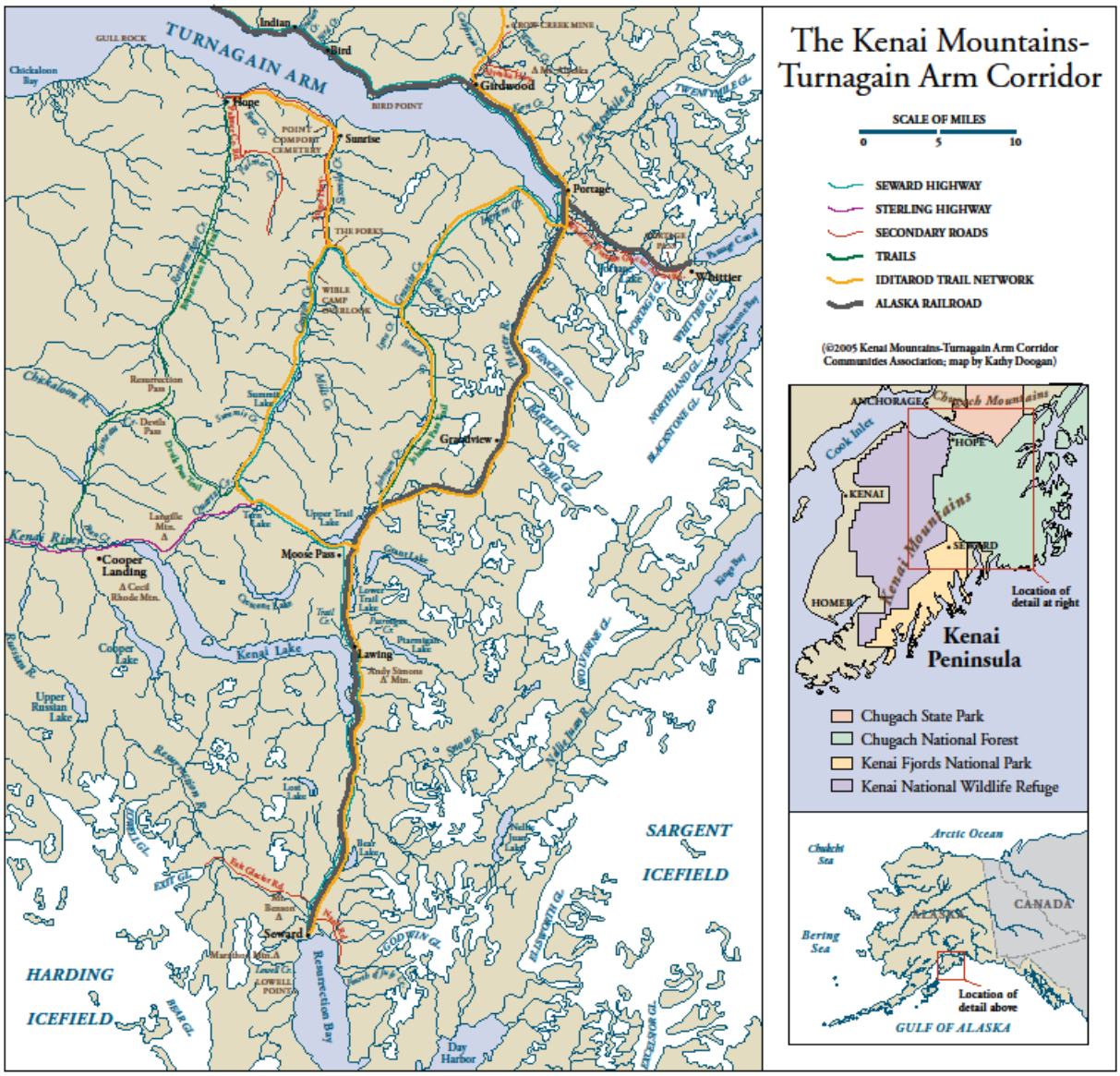


Figure 6: Kenai Mountains-Turnagain Arm National Heritage Area[3]

Encumbrances: The rights-of-way of the Alaska Railroad and Seward Highway cross the project area, but are predominantly located on state, municipal, or private lands. The records of the Bureau of Land Management and Alaska Department of Natural Resources do not indicate any mining claims within project boundaries.[4] According to Forest Service files, as of April 25, 2011, the State of Alaska had not asserted any Revised Statute (RS) 2477 rights of way for historic access routes within the project area. Several power lines are located within the project area, with rights-of-way granted where these lines occupy National Forest System lands.

[3] Map available on the Kenai Mountains-Turnagian Arm National Heritage Area website at http://www.kmtacorridor.org/map.pdf (visited 5/23/2011).

[4] Alaska Department of Natural Resources & U.S. Bureau of Land Management, *Mining Claims Mapper*, available at http://akmining.info/ (visited 4/26/2011).

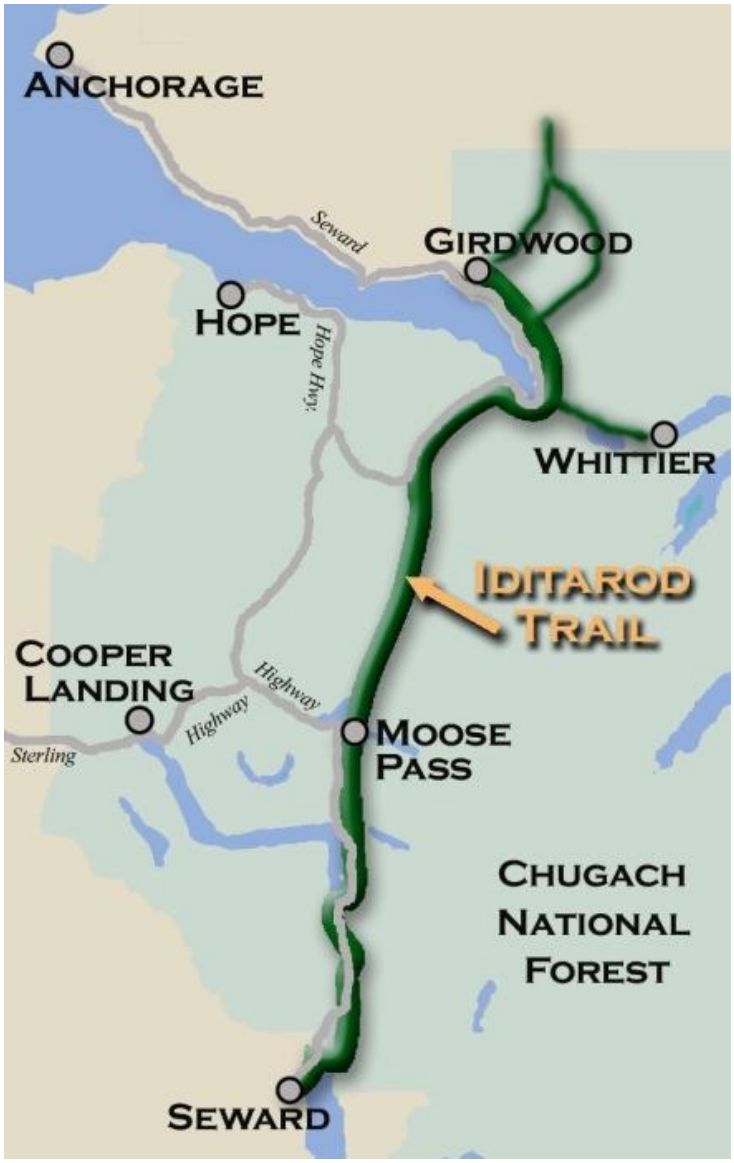


Figure 7. Iditarod National Historic Trail

Land Interests outside of the National Forest System: The Iditarod National Historic Trail (INHT) begins in the City of Seward, and roughly parallels the highway as it bisects the project area (Figure 6). The Iditarod Trail was designated a National Historic Trail with the National Trails System Act in 1978.[5] In general, for purposes of the Alaska National Interest Lands Conservation Act (ANILCA), units of the National Trails System are Conservation System Units (CSUs).[6] Designation of a trail as a CSU carries potential implications for Forest Service management activities including special use authorizations,[7] motorized access,[8] and transportation and utility systems.[9]

Portions of the INHT cross borough, state, or private lands, and at least one right-of-way is still needed to establish a section of trail located beyond National Forest System lands.

[5] Public Law 95-625.
[6] Section 102(4), Public Law 96-487.
[7] See Title 36, Code of Federal Regulations, Part 251, Subpart E (implements section 1307 of ANILCA with regard to the granting of a preference to local residents and certain Native Corporations to obtain special use authorizations for visitor services).
[8] ANILCA (see generally sections 1109-1111).
[9] ANILCA (see generally sections 1102-1106).

Geology Minerals and Soil

Geology

The Salmon Creek Landscape Assessment Area (SCLA) has predominant steep sloped mountains with little known historic production of locatable minerals. Areas with better road/trail access will likely receive the most interest for development; no development is anticipated beyond very small scale operations

Minerals

Management Areas and Mining

The Backcountry Management Area comprises dominant areas of the northwest and east portions of the analysis area.

Locatable minerals activities are allowed consistent with the management intent and mineral material sales are "conditional", the activity is allowed consistent with the management intent, standards and guidelines.

In the Fish, Wildlife and Recreation Management Area, locatable and salable minerals activities are both allowed consistent with the management intent.

Minerals Management Area

Minerals Management Areas are managed for the exploration, development, extraction, and processing of locatable (base and precious metals, such as gold, silver, and copper, etc.) leasable (oil, gas, coal, hard rock minerals.), and salable (sand, gravel, and quarry stone, etc.) minerals.

This management area prescription was developed to address the "Natural Resource Products--Minerals" Interest and specifies management direction for areas with approved plans of operations.

The Forest Plan LRMP Management Prescription map portrays 642 acres (<1%) "Mining Claims with Approved Plan (1998). Currently (April 4, 2011), there are no claims located and no current plans of operations in the watershed.

The LRMP indicates that the "Minerals Management Area" prescription becomes the primary prescription whenever any locatable, salable, or leasable minerals activities occur but only considered "Mining Claims with Approved Plan (1998)" on the prescription map.

There are no active salable minerals (mineral materials) sources or pits in the analysis area on National Forest System lands. Metco, a private business, operates a sand & gravel operation on Resurrection River on private lands in the watershed analysis area, above the Seward Highway Bridge, and has a natural replenishing alluvial supply of materials.

Additional needs for mineral materials may be identified and sites established in the analysis area. There is a huge volume of sand & gravel resources with ready road access but it is mostly in valley floors and not owned by the Chugach National Forest. The Forest would not go into competition for the available market and would not likely develop a site unless private business could not meet the demand. Quality rock (shot

rock, armor stone, etc.) is in short supply and in high demand and can be project driven. If a source is identified with ready road access, development could occur.

Sand & gravel and rock pits are common along all highways and roads on the Kenai Peninsula and were initially developed to support construction of the roads. If adequate mineral materials are identified in any of these pits, additional materials could be disposed if a need is identified. No leasable minerals activities are foreseeable in the analysis area.

Locatable, Leasable, and Salable minerals activities are allowed consistent with the management intent, standards and guidelines in the Chugach National Forest Plan (USDA 2002a)

Soils

The analysis area lies in the Valdez group of the Chugach terrane. The geology is strongly folded and metamorphosed turbidities. These sediments are a collection of the sediments shed by mountains as they were uplifted and eroded (Conner and O'Haire, 1988). Heavy alpine and continental glaciation further shaped the landscape into characteristic hills, valleys, and nunataks.

The climate is wet-transitional between Marine and arctic continental with mild to cool summers and cool winters with moderate snow pack. The mean annual temperature decreased rapidly with elevation while the precipitation increases. At greater than 8,000 feet elevation nearly all precipitation occurs as snow. Moving south, toward Seward, The climate is decidedly warmer and wetter.

Ecological Subsections of the Salmon Creek

The analysis area exists in three Ecological subsections in two Provinces (Table 2) (Davidson, 1999) (Figure 8). The lower elevation Kenai Fjord lands ecosubsection separates the mountainous ice fields of the Chugach Ice field's ecosubsection from the Eastern Kenai Mountains Subsections. The USFS owns all of the Chugach Ice fields and Eastern Kenai Mountains subsections but only owns about half of the Kenai Fjord lands.

The Ice fields make up the southeastern third and the northwester quarter of Salmon Creek. Both of these areas are dominated by alpine glaciations. Here, there is very little soil development on the exposed mountainsides. These areas are largely unvegetated. The exceptions are in the lower valleys and exposed glacial sediments. Here, there is alpine meadow and alder shrubland.

The center bulk of the project area is The Kenai Fjordland; this is also where the most complex vegetation exists. About half is under USFS ownership. This is the most complex landscape of the project area. It also supports the bulk of the vegetation and likely has the highest soil development. Coniferous forest vegetation is commonly interspersed with some broad-leaved cover. Most of the wetlands are found in this eco-subsection.

Table 2. Ecologic Hierarchy of the Salmon Creek Analysis Area

Province	Section	Subsection	Description
Pacific Coastal Mountains Forest-Meadow	Chugach Mountains	Chugach Ice fields (M244Aa)	Rugged mountain peaks and nunataks surrounded by ice. Very little vegetation or soil development
		Eastern Kenai Mountains (M244Ag)	Jagged mountains surrounded by ice and alpine valleys. Alluvial or glacial deposit capped with ash, Rock outcrop.
Pacific Gulf Coastal Forest-Meadow	Northern Gulf Fjord lands	Kenai Fjord lands (M245Aa)	Gently-sloped Hills, valleys, and glacio-fluvial features outwash. Needle-leaved forest cover with section

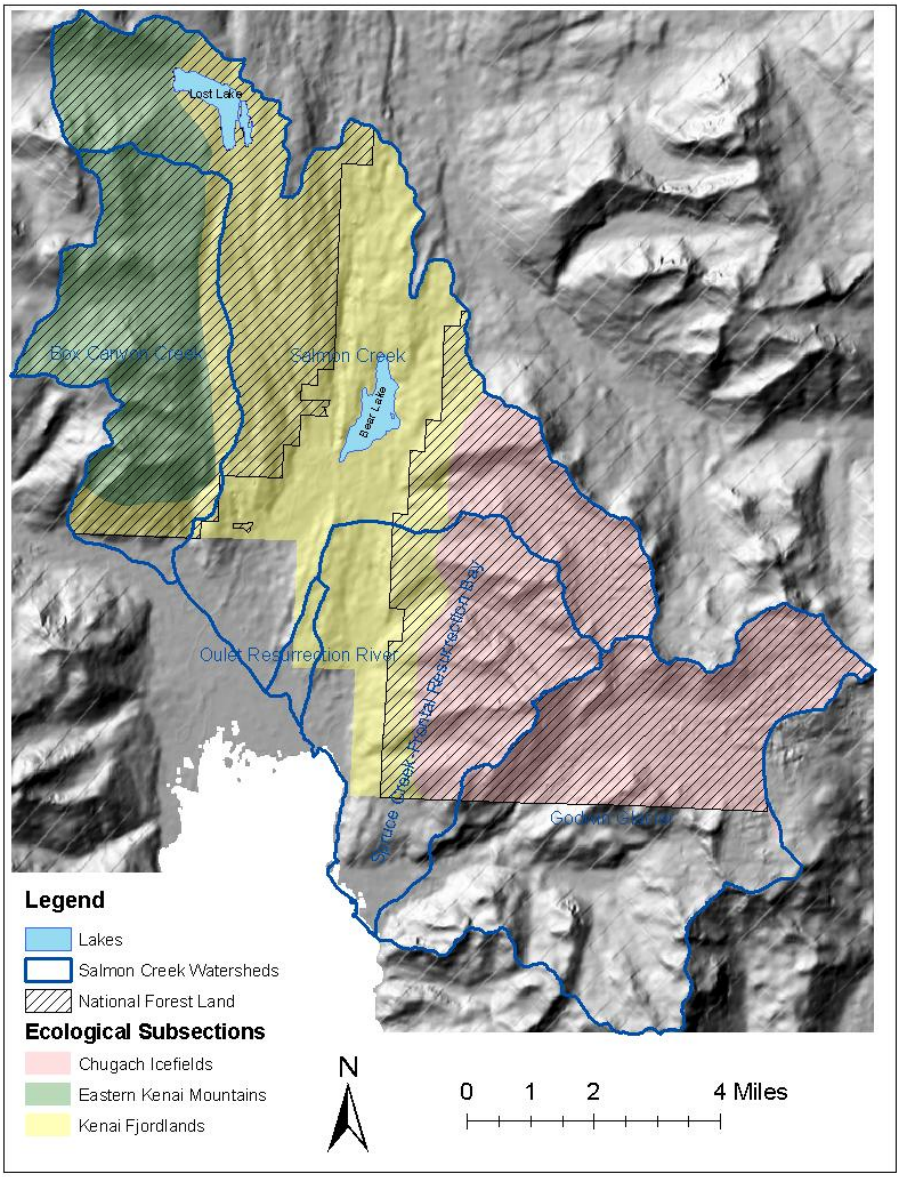


Figure 8. Ecosubsections and watersheds of the Salmon Creek Analysis Area

Landtypes of the Salmon Creek Analysis Area

Landtypes are defined by geomorphic processes, landform and surficial geology. Several types of landtypes occur in the Salmon Creek Analysis Area (Davidson, 1998) (USFS, 1996) (Figure 9)

Alluvial Fans (ALFA) – This mapping unit includes the fan shaped alluvial landform located at the mouth of valley streams where the slope gradient decreases resulting in the deposition of transported sediment. This landform is very unstable because of the constant migration of the stream channel due to the continuous deposition of sediments and high water events resulting from heavy precipitation at higher elevations at the upper portions of the contributing valley. The alluvial soil is deep, moderately to somewhat excessively drained and, gravel, and cobbles with very high permeability. Slope gradient is usually less than 25% and external relief less than 100 vertical feet.

Lakes (CLWA) – This mapping unit includes Lost Lake and Bear Lake.

Glaciers (GLCR) – This association is the most prevalent type found in the analysis area. It includes those landscapes that are covered by glaciers or perennial snowfields where the only exposed ground is typically bedrock nunataks, peaks, ridges, or loose talus. The slopegradient ranges from flat to vertical with external relief from hundreds to thousands of There is rarely any exposed soil or vegetation.

Hills, High Relief (HIHR) -- This association includes bedrock controlled undulating hills and shallow basins, frequently formed by glaciers. It is common in the analysis area and located west of Lost Creek. The slope gradient is usually greater than 35% and external relief ranges from 200 to 1000 feet. The landform is commonly dissected by gorges 500 to 200 feet deep cut into the bedrock. The soils are moderately well to well drained, deep, and loamy to loamy skeletal soils on the slopes. Soils are formed from glacial till or ice-scoured bedrock knobs. Soil type is highly dependent on landscape position. Soils on knobs and shoulder slopes will be shallower and less developed than those on side slopes. Vegetation is dominantly forested, more so than the Hills—Low relief.

Hills, Low Relief (HILR) – This association includes bedrock controlled undulating hills and shallow basins, frequently formed by glaciers. It is not common in the analysis area and located few areas along Lost Creek. The slope gradient is usually greater than 35% and external relief ranges from 50 to 200 feet. The soils range from poorly drained, moderately deep, fine to coarse loams, and organic soils in the basins to moderately well to well drained, deep, loamy to loamy skeletal soils on the slopes. Soils are formed from glacial till or ice-scoured bedrock knobs. Soil type is highly dependent on landscape position. Soils on knobs and shoulder slopes will be shallower and less developed than those on side slopes. Soils in toe slope positions and basins where water collects will tend to develop organic soils and may support wetland vegetation.

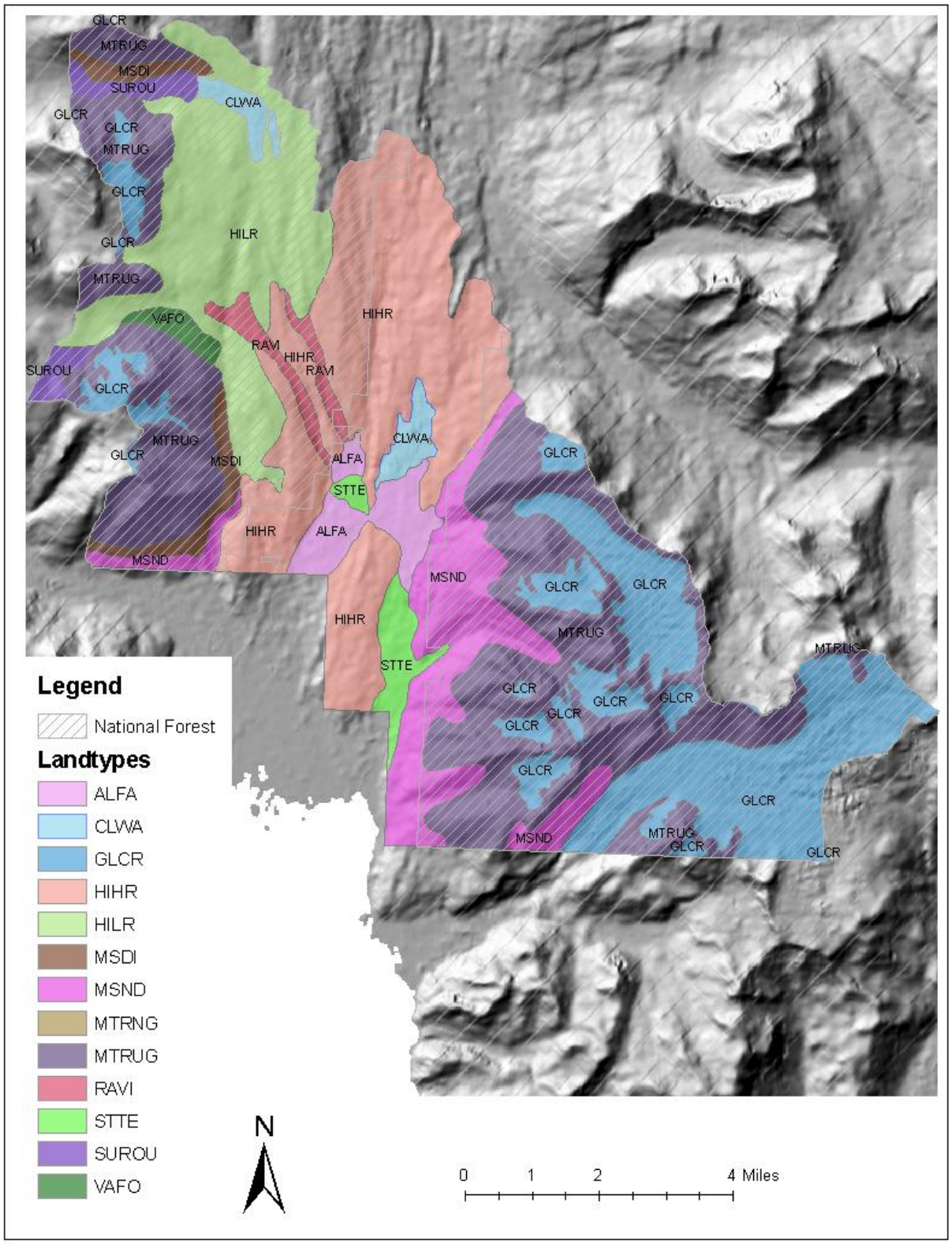


Figure 9. Landtypes of the Salmon Creek Analysis Area.

Mountain Sideslopes, Disturbed (MSDI) – This unit located below alpine landscapes includes the long sideslopes of high relief dominated by rock fall, slides, and avalanches. The slope gradient ranges from 35 to 75%, and the external relief is greater than 1000 feet. Greater than 40% of this mapping unit is dominated by avalanches and slides. The soils range from moderately deep on the upper slopes to deep on the lower slopes and are well drained, loamy to loamy-skeletal, with moderate to rapid permeability. The vegetation consists of shrubs, grasses and forbs in areas of frequent slides and mature spruce/hemlock forests in areas protected from slides.

Mountain Sideslopes, Non-disturbed (MSND) – This mapping unit includes the long sideslopes of high relief that occur below alpine landscapes that are not dominated by rock fall, slides and avalanches. The slope gradient ranges from 35 to 75%, and the external relief is greater than 1000 feet. Less than 40% of this mapping unit is dominated by avalanches and slides. The soils range from moderately deep on the upper slopes to deep on the lower slopes and are well drained, loamy to loamy-skeletal, with moderate to rapid permeability. The vegetation consists of shrubs, grasses and forbs in areas of frequent slides and mature spruce/hemlock forests in areas protected from slides.

Mountains, Rugged (MTRUG) – This mapping unit includes the jagged rocky ridges, peaks, associated side slopes, cirque basins, headwalls, and rock glaciers that are the result of past or present alpine glaciations and frost wedging and weathering. It does not include glaciers or perennial snow fields greater than 40 acres. The slope gradient is usually greater than 65% and the internal relief is greater than 100 feet. Exposed bedrock and unvegetated talus comprise greater than 50% of the mapping unit. The soils are shallow, well drained, loamy or sandy skeletal, with rapid permeability. The vegetation is typically sparse, consisting of low grasses, sedges, forbs, and shrubs.

Ravines (RAVI) – This mapping unit includes steep walled, deeply incised ravines with high channel gradients. They can occur alone or in clusters. . This landform is unstable, and subject to mass wasting. Slope gradient along the ravine sidewalls typically exceeds 75% and the stream gradients exceed 10%. The soils are young, well drained and coarse-textured. The vegetation is indicative of unstable terrain with shrub dominated slopes interspersed with conifer vegetation on the more stable areas.

Stream Terrace (STTE) – This mapping unit includes the river terraces found in valleys where rivers have eroded incised channels in previously deposited alluvium. They have sufficient relief so they are not affected by flooding or annual fluctuations in the water table, but very gentle slopes. Very little of the landform exists in National Forest land. It is associated with the confluence of bear creek and lost creek and adjacent to channels in the Spruce Creek-Frontal Resurrection Bay watersheds. The soils here are deep, highly developed, and well drained. Vegetation is generally forested with Sitka Spruce and Cottonwood dominating.

Subalpine Mountains rounded (SUROU) – This mapping unit includes the rounded ridges, hill tops, and plateaus characteristic of being overridden by large, continental ice sheets. This map unit is of limited extent and only exists on the far west of the project area, most notably west of Lost Lake. This terrain is relatively gentle with slopes less than 45% and internal relief less than 100 feet. It does not include snow fields or glaciers. The soils range from moderately deep on the upper slopes to deep on the lower slopes and are well drained, loamy to loamy-skeletal, with moderate to rapid permeability. The vegetation consists of open meadow to scrubby forest vegetation, typical of a subalpine environment, with krummholz trees. .

Valley floor contained (VAFO) – This mapping unit includes undifferentiated depositional deposits in small or narrow valleys as a result of alluvial processes. It includes only one small area near the western boundary of the project area. The slopes are gentle, generally less than 35% with very low internal relief,

typically ranging from 10 to 35 feet. The alluvial soil is deep, moderately to somewhat excessively drained and, gravel, and cobbles with very high permeability.

Soil of the Salmon Creek Analysis Area

Very little of the Salmon Creek Analysis Area has soil mapping, most of it is in the Non National Forest Lands in the center of the project (Figure 10). The mapped soils are generally coarse-textured, gravel or cobbles making up at least 35% of the soil, moderately to well developed, and well drained (See Table 3).

Table 3. Soils of the Salmon Creek Analysis Area

Soil Map Unit	Soil taxonomic class; slope class (%)	Sum of Acres
101B	Medial-skeletal, mixed Typic Cryorthods; 9-15%	119
101C	Medial-skeletal, mixed Typic Cryorthods; 16-25%	126
101D	Medial-skeletal, mixed Typic Cryorthods; 26-45%	303
101E	Medial-skeletal, mixed Typic Cryorthods; 46-65%	165
101F	Medial-skeletal, mixed Typic Cryorthods; 66-100%	24
102D	Loamy-skeletal, mixed Lithic Cryorthods, Loamy-skeletal, mixed Typic Cryorthods complex; 26-45%	38
102F	Loamy-skeletal, mixed Lithic Cryorthods, Loamy-skeletal, mixed Typic Cryorthods complex; 66-100%	20
205E	Loamy-skeletal, mixed Typic Dystrocryepts*, Loamy-skeletal, mixed Typic Cryorthods complex; 45-65%	1
208C	Loamy-skeletal, mixed Typic Dystrocryepts *; 16-25%	22
208E	Loamy-skeletal, mixed Typic Dystrocryepts *; 46-65%	27
W	Fresh water	31
	Total	**877**

*Changed from Dystric Cryochrepts as originally named to reflect 2010 Soil Taxonomy (Soil Survey Staff, 2010)

Most of the soils are well-drained and steep (Davidson, 1989). They have developed into spodosols, which is typical of the cool wet climate of Salmon Creek.

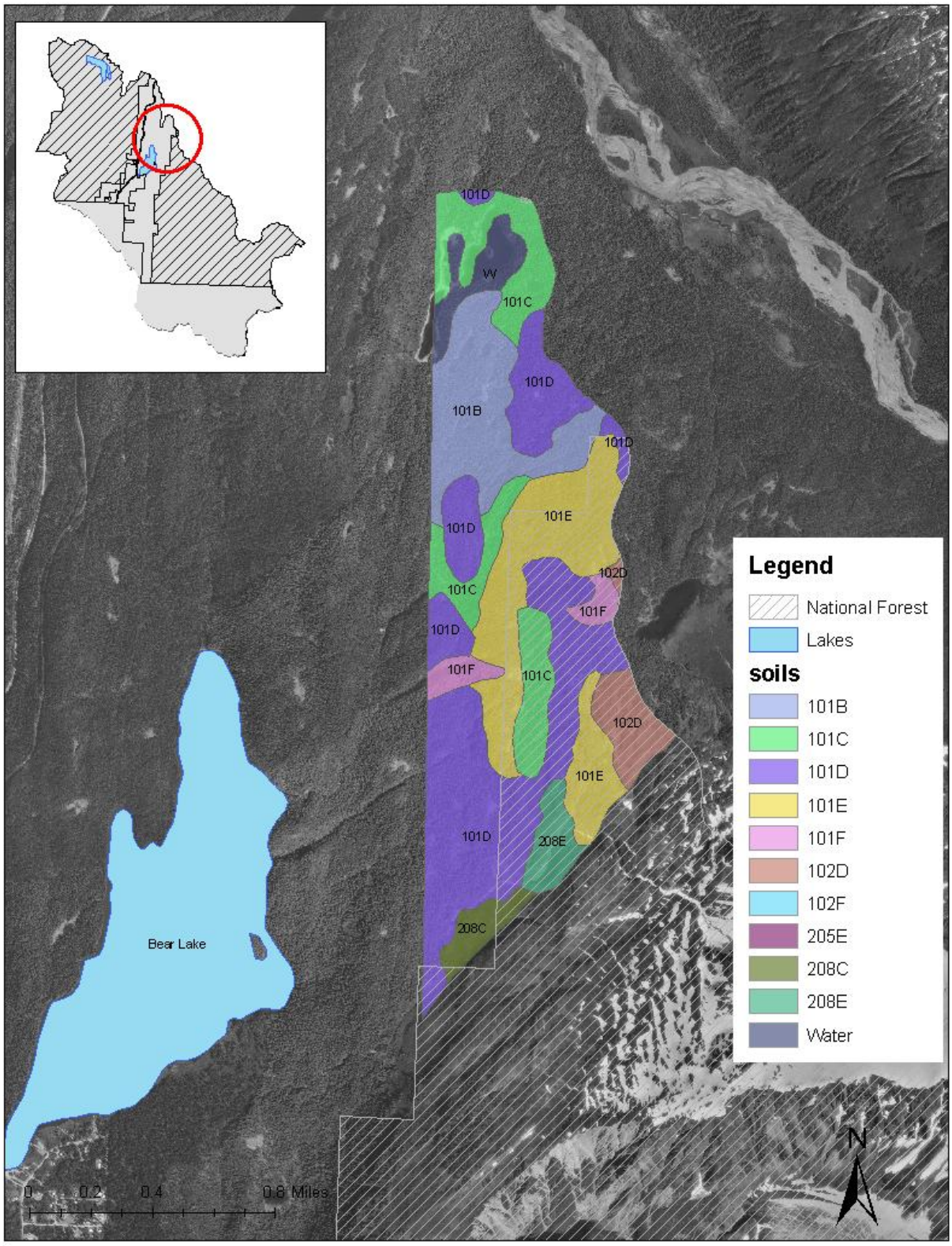


Figure 10. Soils of the Salmon Creek Analysis Area

Wetlands of the Salmon Creek Analysis Area

There are several different types of wetlands in the Salmon Creek Analysis Area (Table 4) (Figure 11). Each different wetland type provides a different function and value to the surrounding. The wetlands in Salmon Creek are classified by the National Wetlands Inventory of the US Fish and Wildlife Service (NWI) (Cowardin, 1979). Private lands were mapped as part of the Kenai/Seward wetland classification project as well (Gracz and Van Patten, 2007). Only the wetland types on National forest land will be described. Most of the wetlands are found in the private land in the center of the project area and in the mountainous areas to the west.

Table 4. Wetlands in the Project Area

Wetland Type and Ownership.	Acres
National Forest	**746.4**
Freshwater Emergent Wetland	29.3
Freshwater Forested/Shrub Wetland	63.9
Freshwater Pond	107.4
Lake	471.1
Riverine	74.7
Municipality, City, Town, Private	**108.9**
Freshwater Forested/Shrub Wetland	22.3
Freshwater Pond	8.5
Lake	3.5
Riverine	74.6
State - conveyed (Current ownership unknown)	**668.6**
Freshwater Emergent Wetland	4.1
Freshwater Forested/Shrub Wetland	75.4
Freshwater Pond	78.7
Lake	445.4
Riverine	65.0
Grand Total	**1524.0**

Palustrine Wetlands—Freshwater Emergent, Freshwater Forested/Shrub Wetland

These are the most common wetlands in the Analysis Area. These correlate closely to the Depressional or Kettle Ecosystem Wetland types in the Seward wetland mapping (Gracz and Van Patten, 2007). They are not influenced by ocean tide and persistent emergent vegetation (vegetation such as rushes) occupies 30% or more of the area. They were found on glacial and lowland terrain. The difference between Depressional and Kettle Ecosystems in hydrologic connectivity: Kettles are connected to other kettles or streams while depressional wetlands are isolated.

The soils are typically deep peats ranging to poorly drained mineral soils. Vegetation follows a sequence as drainage improves from open water with pond lily or pond weed, to emergent sedges, to terrestrial sedges and forbs, to dwarf shrubs, finally to forested peatlands. The most common plant community is blue joint grass or dwarf shrub communities.

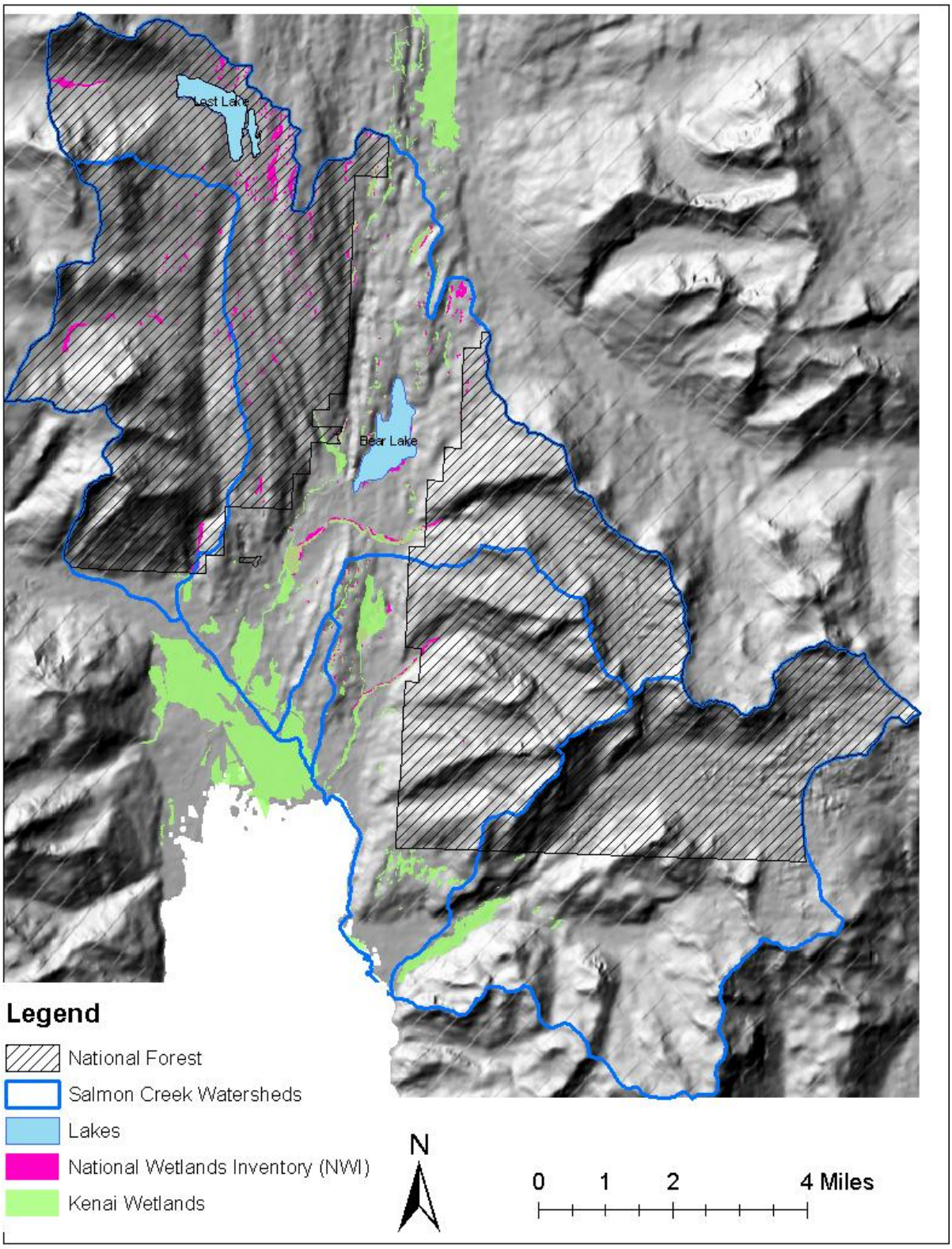


Figure 11. Wetlands of the Salmon Creek Analysis Area

Freshwater Pond

These wetlands are in natural depressions from moraine or in Kettle-and kame topography. They are similar to the above Palustrine wetlands. There is standing water throughout the growing season. The edges of these ponds usually have emergent plant communities (Sedges) and floating plants like pond lily or pond weed are common (Gracz and Van Patten, 2007).

Lake/Lacustrine

Lakes are simply larger Freshwater Ponds. There is standing water above the soil surface for the entire growing season. The two large lakes, Lost Lake and Bear Lake, make up the bulk of this wetland type. Fringes of the lakes often have pond lily grading to sedges and sweetgale. Vegetation communities along the margins of the lake are similar to the palustrine wetlands.

Riverine

The riverine wetlands on National Forest Land are the glacier-fed braided streams and channels and associated terraces. These are similar to the Riparian ecosystems described as RD4C or RD4T2 by the Seward wetland mapping (Gracz and Van Patten, 2007). Much of this map unit is glaciofluvial gravels and open water. Little to no vegetation is growing in the young, poorly developed, coarse-textured soils.

The upper terraces are a mosaic of forested/scrubby upland (non-wetland) and wetlands. The soils are generally young, poorly drained mineral soils under the alder/bluejoint vegetation that characterizes the youngest terraces. As the terraces age, the soils develop further under more Sitka Spruce/Cottonwood vegetation. Typically, the older terraces are the uplands.

Mass Wasting and other erosional processes of the Salmon Creek Analysis Area

Mass wasting and glacial retreat are the dominant sediment-producing geomorphic processes in the Analysis Area.

Mass Wasting and Erosion

No mass wasting or landslide mapping exists for the Salmon Creek Analysis Area; however, a cursory look at the orthophotos in ArcGIS shows several highly landslide-prone areas. These are naturally-occurring landslides, talus slopes, and avalanche tracts that are common on glacial landscapes.

Most of the landslides occur in the northwestern portion of the Salmon Creek Analysis Area. Box Creek drainage and some of the tributaries to Box Creek (Figure 12) has several bare landslides or talus slopes that may be sources of sediment for the stream. Lost Creek and it's tributaries has several landslides and talus slopes along the stream banks as well.

Please refer to the Hydrology report for a discussion on stream erosion.

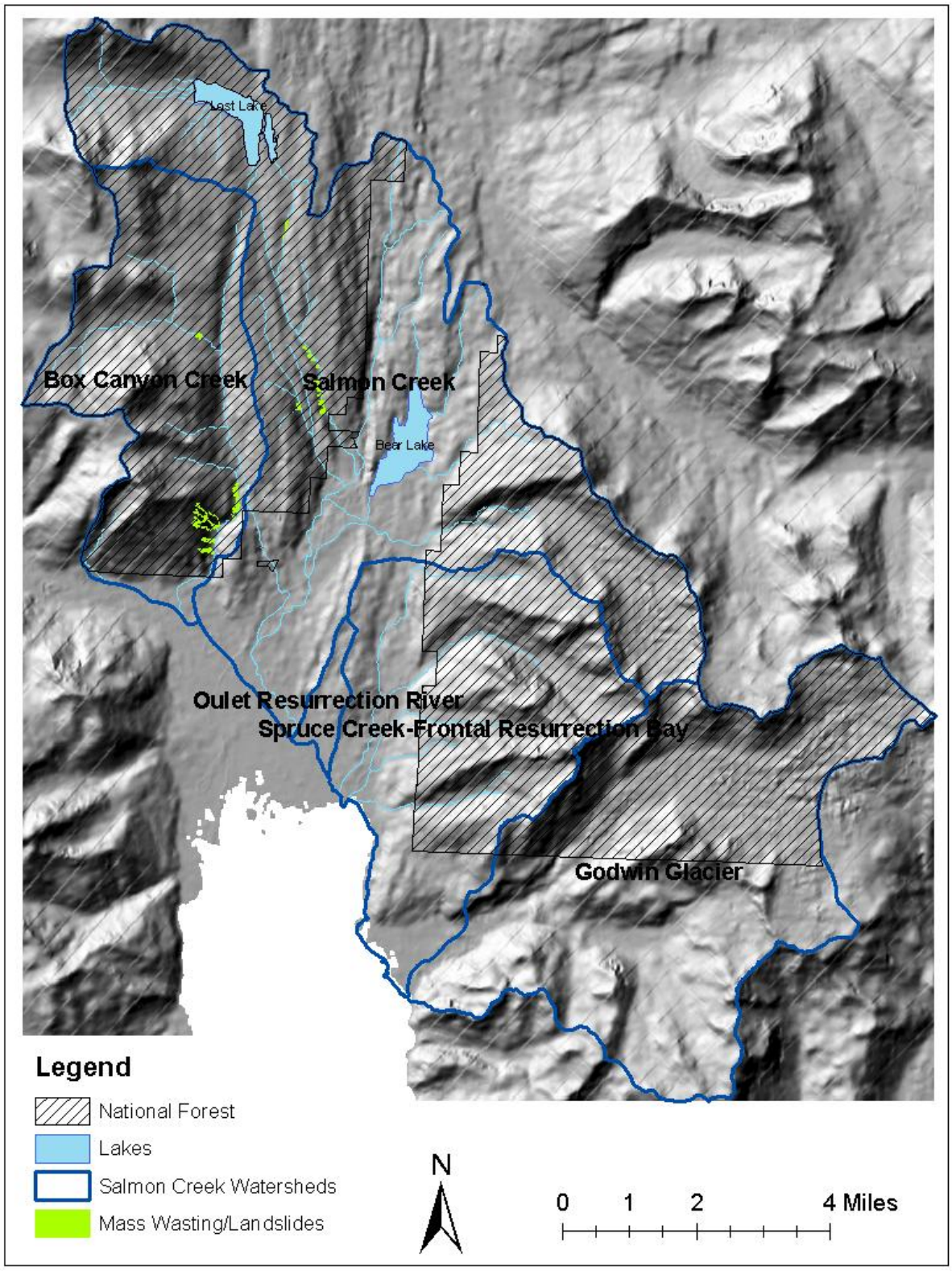


Figure 12. Landslides in the Salmon Creek Analysis Area

Glacial Retreat

There are about 8,949 acres of glaciers in the Analysis Area, all of which are owned by the Forest Service (Figure 9). The glaciers are actively retreating throughout the entire project area. Glacial thinning or melting is linked to rise in seal level. As glaciers retreat, sediments are exposed and soils begin to develop. Colonizing vegetation and precipitation primarily drive the soil development in these new glacial sediments. Rain and snowmelt leach soluble materials, creating zones of depletion and zones of accumulation in the soil. The roots from pioneering species input carbon, and sometimes nitrogen in the case of Alder, to the soil. The detritus from dead vegetation accumulates on the soil surface, creating a protective organic horizon and creating a carbon pool that can be translocated deeper into the soil (Crocker and Major, 1955). The leaching and the carbon inputs from the vegetation drop the pH through the whole soil. Micro flora, fungi and bacteria, rapidly colonize the site in close association with the vegetation.

Hydrology

Climate

The climate of the Salmon Creek analysis area is primarily influenced by the moisture-laden air of the Gulf of Alaska to the south. At elevations near sea level at Seward, annual temperatures average about 40 degrees F, average maximum July temperatures reach 59 degrees F, and average minimum January temperatures drop to 20 degrees F (Table 5, Figure 12) (Western Regional Climate Center, 2011). The maritime climate near Seward moderates temperature fluctuations, causing cooler summer temperatures and warmer winter temperatures than interior portions of the Kenai Peninsula or Alaska. Average temperatures, as well as the moderating effect of the maritime climate, decrease with increasing elevation and distance from Resurrection Bay.

The analysis area lies in a coastal area of the southern Kenai Peninsula, which is subjected to moist air that circulates over Prince William Sound and the Gulf of Alaska to the south and east. As a result, average annual precipitation is high, ranging from about 68 inches at the lower elevations to over 100 inches in the higher elevations (Table 5 (Western Regional Climate Center, 2011; USDA Natural Resources Conservation Service, 2011). Precipitation is the heaviest in September and October, and winter months receive more precipitation than summer months. April, May, and June are generally the driest months of the year.

Table 5: Climate summary for weather stations within and adjacent to the Salmon Creek analysis area.

Station	Location				Temperature		
	Elevation (ft)	Latitude (ddmm)	Longitude (ddmm)	# of years of data	Average Daily Temp (F)	Average Max July Temp (F)	Average Min Jan Temp (F)
Seward, Alaska [1]	40	60 07	149 27	57	39.9	62.3	20.3
Seward 9NW, Alaska [1]	490	60 12	149 37	23	35.9	66.3	11.1
Exit Glacier [2]	400			21	-	-	-
Grouse Creek Divide [2 3]	700	60 16	149 21	24	-	-	-

Station	Precipitation						
	Avg. Annual Precip (inches)	Average March 1 Snowpack Depth		Average May 1 Snowpack Depth		Peak snowpack of record (by SWE)	
		inches	SWE*	inches	SWE	inches	SWE
Seward, Alaska [1]	68.1	-	-	-	-	-	-
Seward 9NW, Alaska [1]	71.8	-	-	-	-	-	-
Exit Glacier [2]		50	15.2	30	12.3	89	31.2
Grouse Creek Divide [2 3]	60.0	52	15.7	44	16.6	85	36

[1] Weather station data (WRCC, 2011); [2] Snow course data (USDA NRCS, 2011)

[3] SNOTEL Site (USDA NRCS, 2011); * SWE=Snow water equivalent, in inches

Snow generally falls at all elevations of the analysis area between the months of October and April. Winter rain is common in the lower elevations. Snowfall and snowpack increase dramatically with elevation. The lower elevations near Seward receive about 83 inches of snow annually, with snowpack depths generally averaging less than 10 inches. Higher elevations in the analysis area receive considerably more snow, with average maximum annual snowpacks over 50 inches (USDA Natural Resources Conservation Service, 2011; Western Regional Climate Center, 2011) (**Table 5**). In the low elevations, snowfall accounts for less than 25% of the total annual precipitation. In the higher elevations, snowfall accounts for over 50% of the total annual precipitation.

Watershed Morphology

The analysis area for this landscape assessment is defined by sixth-level watershed boundaries from the statewide Watershed Boundary Dataset (WBD) that was recently certified in 2010. The following sixth-level watersheds are part of the analysis area (12):

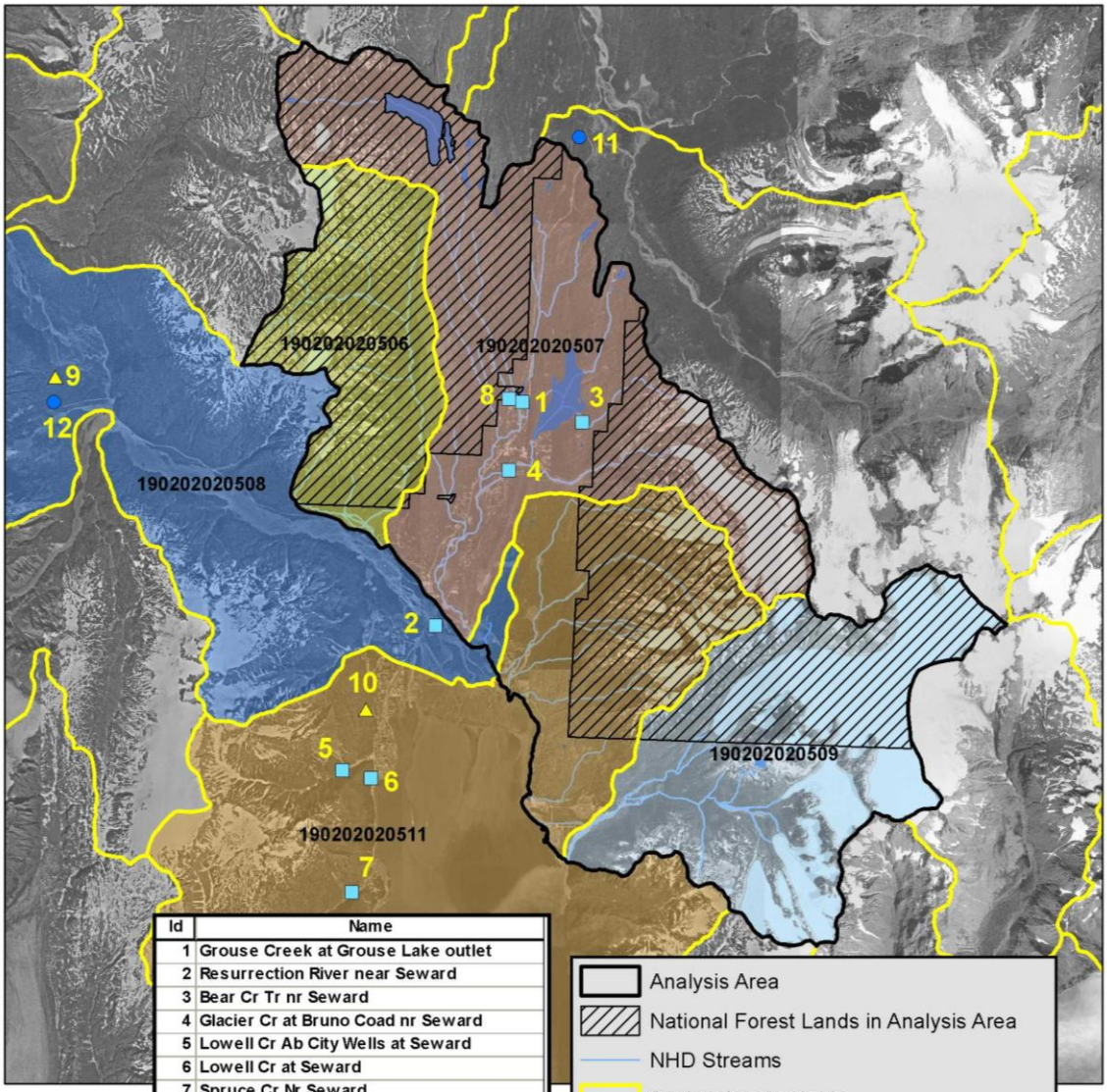
- Box Canyon Creek (HUC 190202020506)
- Salmon Creek (HUC 190202020507)
- Godwin Glacier (HUC 190202020509)
- A portion of Spruce Creek-Frontal Resurrection Bay (HUC 190202020511)
- A portion of Outlet Resurrection River (HUC 190202020508)

The southwestern boundary of the analysis area is defined by the coastline of Resurrection Bay.

The analysis area covers 96.4 square miles and consists of the following four distinct and non-converging drainages: Box Canyon Creek, Salmon Creek, Sawmill Creek, and Fourth of July Creek. Each of these systems drains into either Resurrection River or Resurrection Bay. The analysis area stretches across a width of about 18 miles. Salmon Creek is the largest drainage in the analysis area, stretching about 13 miles from the headwaters of Lost Creek to Resurrection Bay. Although Box Canyon Creek flows into the Resurrection River, it is included within this assessment rather than the Resurrection River Landscape Assessment (USDA Forest Service, Chugach National Forest, 2010) because the Resurrection River analysis area was delineated using "old" watershed boundaries based on historic mapping of Box Canyon Creek flowing into Salmon Creek to the east.

Forest Service lands primarily include uplands, headwater streams, and glaciers. The valley floor of the Salmon Creek drainage from Seward to Grouse Creek Divide, including Bear Lake, is non-National Forest lands, as are the lower reaches of the Sawmill Creek drainage, most of the Fourth of July Creek drainage, and the coastline along Resurrection Bay.

Elevations within the watershed range from sea level to about 5800 feet at the head of the Godwin Glacier watershed. Based on current National Hydrography Dataset (NHD) mapping, glaciers cover about 10,347 acres, or 17% of the analysis area. Glaciers are present primarily in the southern half of the analysis area, while the northern half has very little glacial influence. Valley morphology differs drastically between the various drainages in the analysis area, with a combination of glacially carved U-shaped valleys, small glacially carved hanging valleys, deeply incised canyons carved by post-glacial fluvial erosion, and remaining valley and cirque glaciers at high elevations. Vertical relief ranges up to 5000 feet. Lakes cover 1044 acres (2%) of the analysis area, with the largest being Lost Lake (368 acres) and Bear Lake (416 acres).



Id	Name
1	Grouse Creek at Grouse Lake outlet
2	Resurrection River near Seward
3	Bear Cr Tr nr Seward
4	Glacier Cr at Bruno Coad nr Seward
5	Lowell Cr Ab City Wells at Seward
6	Lowell Cr at Seward
7	Spruce Cr Nr Seward
8	Lost Creek near Seward
9	Seward 9NW, Alaska
10	Seward, Alaska
11	Grouse Creek Divide
12	Exit Glacier

HUC_12	HU_12_Name
190202020511	Spruce Creek-Frontal Resurrection Bay
190202020508	Oulet Resurrection River
190202020507	Salmon Creek
190202020509	Godwin Glacier
190202020506	Box Canyon Creek

HUC-6	Sixth-level Watershed Name	Total wshed Area (ac)	Area in analysis area (ac)	% of whsed in analysis area
190202020506	Box Canyon Creek	9,418	9,418	100%
190202020507	Salmon Creek	23,815	23,815	100%
190202020508	Oulet Resurrection River	35,905	557	2%
190202020509	Godwin Glacier	16,441	16,441	100%
190202020511	Spruce Creek-Frontal Resurrection Bay	57,315	11,462	20%

Figure 13: Watersheds and data collection sites in the Salmon Creek analysis area.

Streams

A total of 106 miles of stream channel lie within the analysis area, as mapped by the National Hydrography Dataset (NHD). This represents a stream density of 1.1 stream miles per square mile. A total of 93 miles of stream channels within the analysis area that lie within the boundary of the Chugach National Forest were also previously mapped and assigned channel types by the Chugach National Forest. Channel types were based on the Tongass National Forest Channel Type User Guide (USDA Forest Service, Alaska Region, 1992) (Figure 13). NHD stream channel mapping does not align perfectly with this "legacy" Chugach National Forest mapping, but is likely more accurate. However, the Chugach National Forest still relies on its legacy stream mapping because numerous attributes are associated with these spatial stream data. Streams within the analysis area but outside of the Forest boundary are mapped based on NHD, and no channel types are assigned to those channels.

Of the USFS-mapped streams in the analysis area, 39% are "High Gradient Contained" Channels, primarily in steep headwater areas. A total of 16% of the USFS-mapped streams are "Moderate Gradient Contained" channels, 15% are "Glacial Outwash" channels, and 9% are "Moderate Gradient Mixed Control" channels. "Alluvial Fan," "Floodplain," and "Palustrine" channels comprise a small percentage of channels, located in the valley floors.

The analysis area consists of the following four parallel non-converging drainages:

1. Box Canyon Creek drains a high plateau near Lost Lake and runs 6.9 miles through a deeply incised canyon and into the Resurrection River valley. This is primarily a "Moderate Gradient Contained" and "Moderate Gradient Mixed Control Channel." The lower reach is an active "Alluvial Fan" channel where it emerges from the canyon in the Resurrection River valley.

2. Salmon Creek, the largest drainage in the analysis area, is fed by several large tributaries. Salmon Creek itself flows 6.7 miles from Bear Lake Glacier to Resurrection Bay and is primarily a "Glacial Outwash" channel occupying a wide glacially sculpted valley floor. The upper portion of this drainage is also known as "Kwechak Creek." Lost Creek is the major tributary to Salmon Creek, flowing 7.7 miles from its source upstream of Lost Lake to its confluence with Salmon Creek just west of Bear Lake. Lost Creek is primarily a "High Gradient Contained" and "Moderate Gradient Contained" channel, draining steeply from the Lost Lake plateau to the bottom of the glacially sculpted Salmon Creek valley. "Grouse Creek" drains about 4 miles from Grouse Creek divide to its confluence with Lost Creek, via Grouse Lake. This is primarily a "Moderate Gradient Contained" channel. Bear Creek is primarily a "Moderate Gradient Mixed Control" channel, flowing about 1 mile from the outlet of Bear Lake to its confluence with Lost Creek.

3. The Sawmill Creek drainage consists of five tributaries that all converge on the coastal flats along Resurrection Bay. These streams are primarily "Glacial Outwash" and "High Gradient Contained" channels, draining steep, narrow valleys, each with a small remnant glacier at the head of the valley.

4. Fourth of July Creek flows 4.8 miles and drains large glaciers at the southeastern end of the analysis area. Its major tributary, Godwin Creek, drains 2.3 miles from the terminus of the Godwin Glacier, the largest glacier in the analysis area. These stream channels are unclassified, but would most likely be classified as "Glacial Outwash" channels.

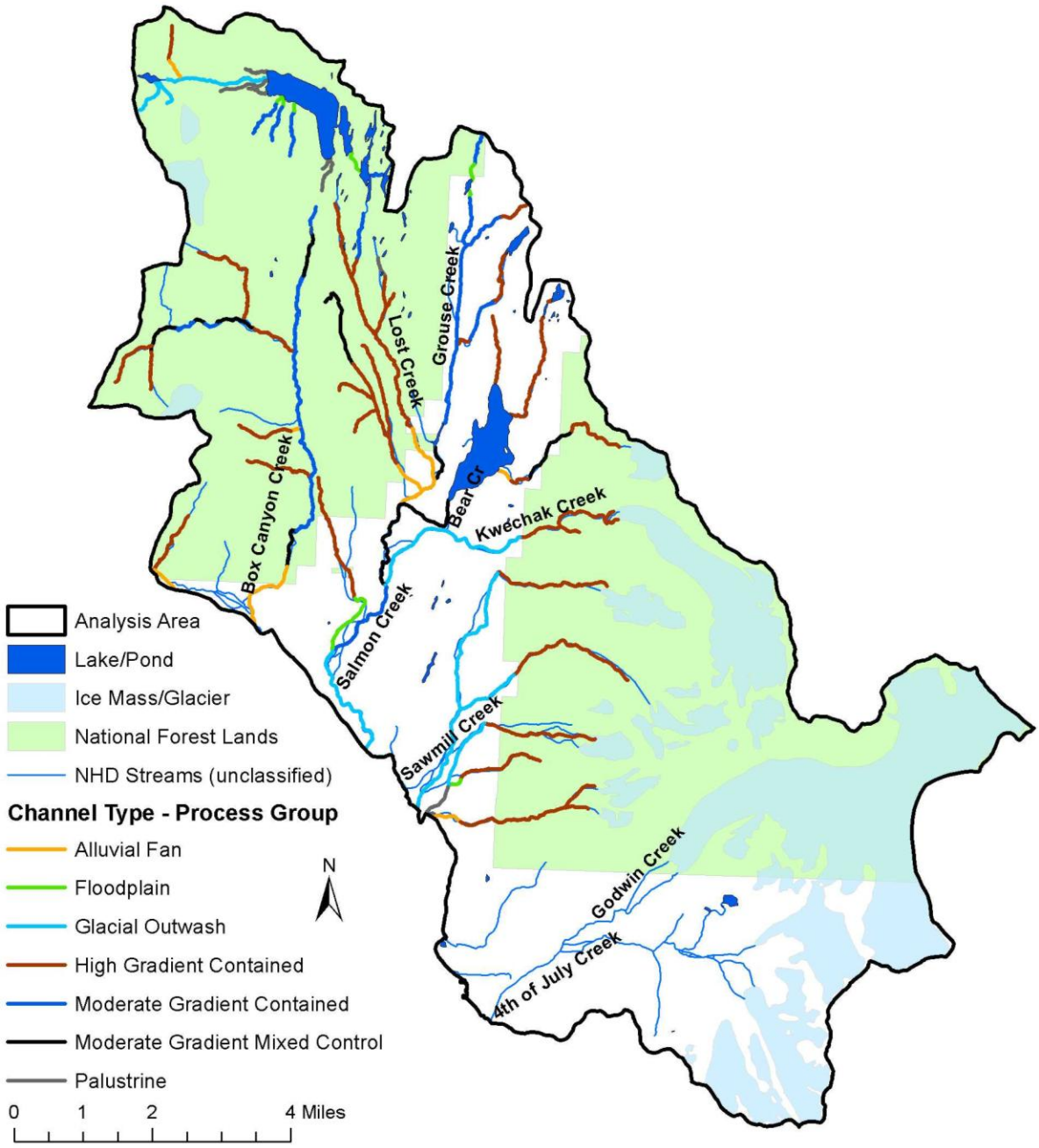


Figure 14. Stream channel type process groups in the Salmon Creek analysis area. Data from USDA Forest Service.

Wetlands

Wetland mapping coverage as part of the US Fish and Wildlife Service National Wetland Inventory includes the entire analysis area (Figure 14). Wetlands cover a total of 2280 acres, or 3.7% of the analysis area, primarily on non-National Forest lands in the valley floors of the lower reaches of the larger drainages (Salmon Creek, Box Canyon Creek, and Fourth of July Creek). Only 389 acres, or 17% of the wetlands in the analysis area lie on National Forest lands, primarily scattered throughout the uplands in the northern half of the analysis area.

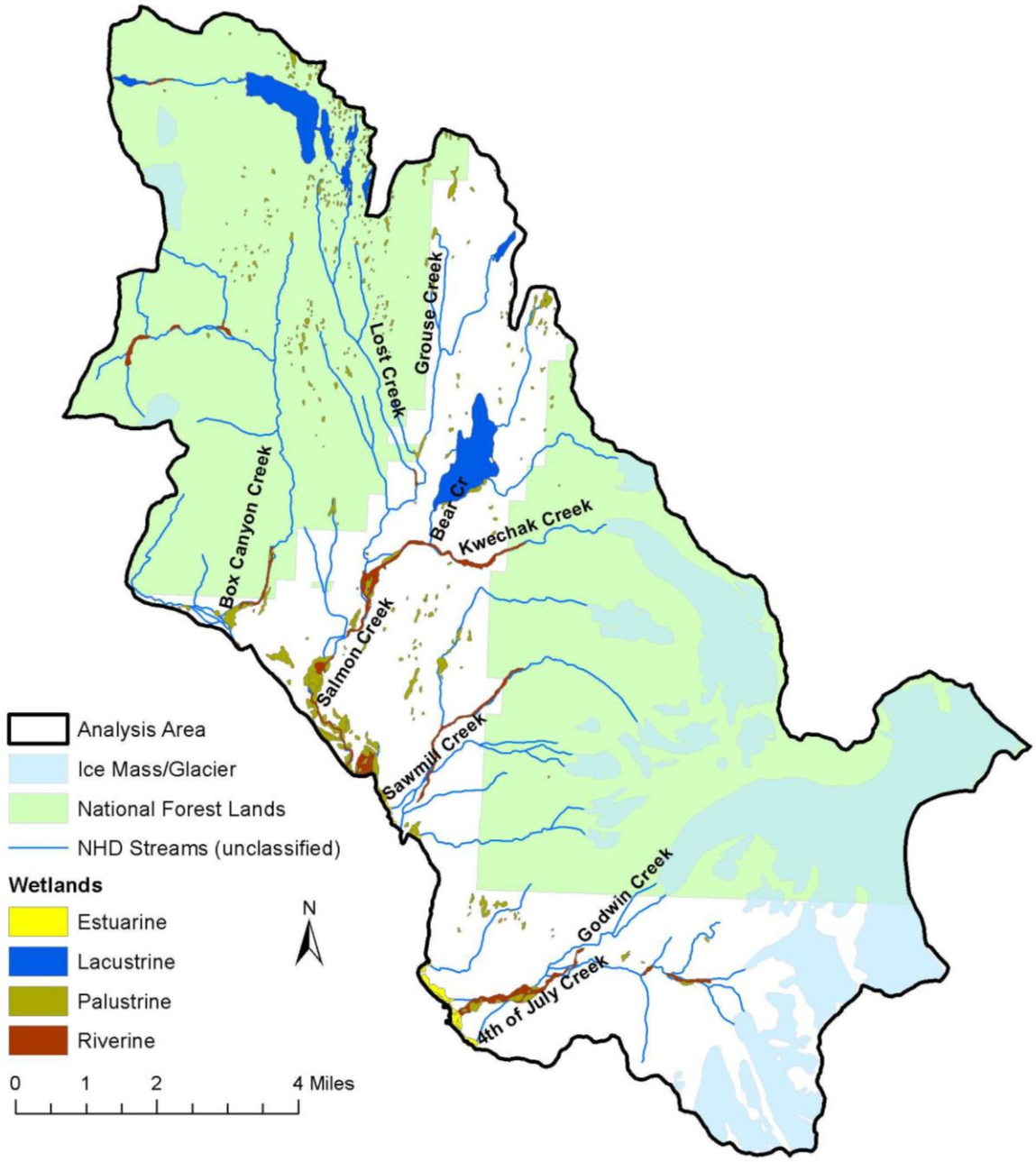


Figure 15. Wetland classification for the Salmon Creek analysis area. Data from US Fish and Wildlife Service wetland mapping.

Mapped wetlands in the analysis area include 919 acres of lacustrine wetlands (areas associated with lakes), 782 acres of palustrine wetlands (areas associated with swamps, bogs, ponds, beaver ponds, and wetlands), 454 acres of riverine wetlands (areas associated with rivers), and 126 acres of estuarine wetlands (areas associated with estuaries in tidal zones). The lacustrine wetlands include Lost Lake (368 acres) and Bear Lake (416 acres). Palustrine wetlands are present in the floodplains of the lower reaches of the larger drainages and scattered throughout the uplands in the form of muskegs, bogs, and ponds. Riverine wetlands are located in the stream courses of the larger drainages. Estuarine wetlands are located along the coast at the mouths of Sawmill and Fourth of July Creeks.

Wetlands were also mapped in 2006 in the Seward area as part of the Seward Wetland Mapping Project conducted through the Kenai Watershed Forum and the Kenai Peninsula Borough (Kenai Watershed Forum, 2007). This project mapped an area of 24,600 acres of non-National Forest lands, covering a portion of the analysis area. This local mapping effort produced greater detail and better accuracy than the National Wetland Inventory mapping.

Stream flows

Stream flows in the Salmon Creek analysis area are primarily controlled by early summer snowmelt runoff, mid-summer glacial melt runoff, and late summer/fall rainfall runoff. Drainages in the northern portion of the analysis area, including Box Canyon Creek, Lost Creek, Grouse Creek, and Bear Creek, are primarily non-glacial in origin, and stream flows are controlled by a combination of snowmelt and rainfall runoff. Drainages in the southern half of the analysis area, including Salmon Creek, Sawmill Creek, Fourth of July Creek, and Godwin Creek, are primarily glacial in origin, and stream flows are largely controlled by glacial melt. Stream flows in all drainages in the analysis area are heavily influenced by the intense late summer and fall rainstorms that generally occur in this area. These storms can create intense, short duration floods, particularly in the small, steep drainages near Seward. Heavy rainfall that occurs during periods in which glacial melt is already high can result in large floods. Historically, the largest floods in the area are the result of "outburst" floods caused when a landslide temporarily dams a stream in a narrow confined canyon. Several streams in the area are susceptible to landslide debris dam outburst floods.

Historical stream flow data from the US Geological Survey exist for 8 sites on rivers and streams within or in the vicinity of the Salmon Creek analysis area (Table 6, Figure 12) (US Geological Survey, 2011). Four of these sites have very short periods of record. Only the Grouse Creek site is currently in operation as a real-time stream gauge, funded under a partnership between the US Geological Survey and the Kenai Peninsula Borough.

Flow regimes for streams in the Salmon Creek analysis area vary by stream type. Hydrographs for non-glacial streams such as Grouse Creek generally exhibit a fairly consistent snowmelt peak flow in early summer, and a highly erratic series of rainfall peak flows in the fall and early winter (Figure 15). The dominance of the snowmelt peak over the rainfall peaks increases with increasing elevation in the analysis area. Grouse Creek has a fairly small and short snowmelt peak in May and June, but Lost Creek likely has a larger and longer snowmelt-derived peak flow that extends into July. In most streams in the analysis area, the maximum peak flows resulting from fall rainstorms are considerably higher than the maximum peak flows from snowmelt runoff. Winter base flows are low, but most drainages respond to winter rainfall because of their low elevations and the maritime climate.

Table 6. Stream flow data summary for the Seward area

USGS Station Name	USGS Station Number	Type of Data	Years of Data	Latitude (NAD27)	Longitude (NAD27)	Drainage Area (sq mi)
Grouse C At Grouse Lk Outlet Nr Seward AK	15237730	Daily, Peak	1997 - 2010	60°11'54"	149°22'24"	6.22
Resurrection R at Seward AK	15237700	Daily, Peak	1964-1968	60°08'30"	149°25'00"	169
Bear C Tr Nr Seward AK	15237800	Daily, Peak	1966-1968	60°11'35"	149°20'20"	1.63
Glacier C at Bruno Road Nr Seward AK	15237900	Peak, gauge ht	1986 - 2007	60°10'49"	149°22'46"	n/a
Lowell C Ab City Wells At Seward AK	1523849020	Daily, Peak	1993 - 1995	60°05'59"	149°27'51"	3.73
Lowell C At Seward AK	15238500	Daily, Peak	1965 - 1993	60°05'55"	149°26'35"	4.02
Spruce C Nr Seward AK	15238600	Daily, Peak	1967 - 2008	60°04'10"	149°27'08"	9.26
Lost Creek Near Seward AK	15238000	Peak	1949 - 1987	60°11'54"	149°22'42"	8.42

USGS Station Name	# Years of peak flow data	Extreme instantaneous peak flow (cfs)	Estimated 2-year flow (Q2) (cfs) [1]	Estimated 10-year flow (Q10) (cfs) [1]	# Years of daily flow data	Peak average daily flow (cfs)
Grouse C At Grouse Lk Outlet Nr Seward AK	12	901	-	-	14	56
Resurrection R at Seward AK	4	19,000	-	-	4	8,900
Bear C Tr Nr Seward AK	2	134	-	-	2	43
Glacier C at Bruno Road Nr Seward AK	15	4,200	-	-	-	-
Lowell C Ab City Wells At Seward AK	2	1,810	-	-	2	555
Lowell C At Seward AK	5	1,200	-	-	6	160
Spruce C Nr Seward AK	42	13,600 [2]	1,620 cfs (175cfs/sqmi)	2,720 cfs (294cfs/sqmi)	32	302
Lost Creek Near Seward AK	13	14,000 [2]	342 cfs (41 cfs/sqmi)	819 cfs (97 cfs/sqmi)	-	-

[1] *Estimated flow statistics from Curran et al. (2003).*

[2] *Peak flows from Oct 1986 flood, may be result of debris jam breakout flood. Next highest flood peak is 3640 cfs for Spruce Creek and 920 cfs for Lost Creek.*

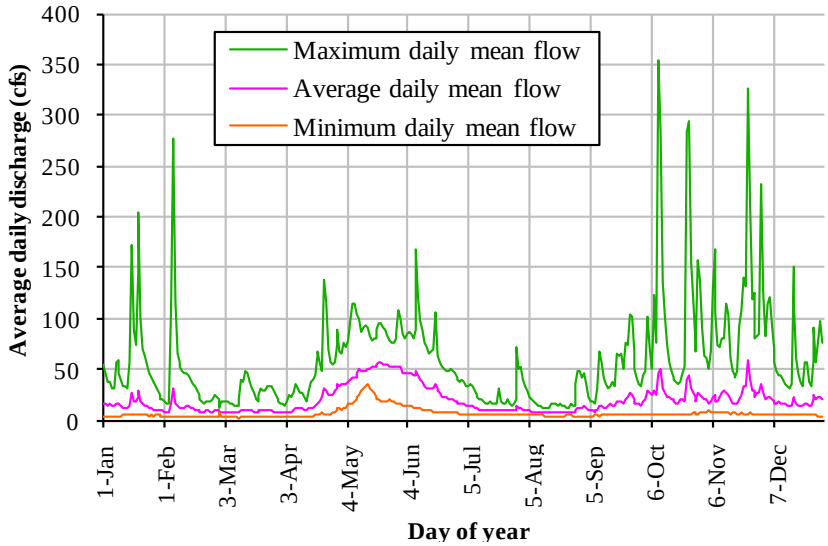


Figure . Average daily stream flows for Grouse Creek at Grouse Lake outlet. Data from US Geological Survey (2011).

Hydrographs for glacial streams in the area exhibit a glacial melt component that extends the snowmelt peak runoff into July and August. Small glacial drainages also exhibit highly erratic rainfall peak flows in the fall and early winter, and winter baseflows are generally minimal.

Peak flow magnitudes in streams in the Seward area are very high per square mile of drainage area. US Geological Survey flow data show the 10-year flood magnitude varying from about 100 to 300 cfs per square mile of drainage area in streams near Seward (Curran et al., 2003). Several streams in the Seward area are known to experience extreme flood events as a result of debris dam outburst floods caused when a landslide or avalanche temporarily dams a stream in a narrow confined canyon. This has occurred on Box Canyon Creek, and may also be the cause of the extreme peak flows measured on Spruce Creek, Lost Creek, Japp Creek, and Godwin Creek during the October 1986 floods. The largest peak flow resulting from a debris dam outburst flood during the October 1986 flood was estimated to be 2200 cfs per square mile on Godwin Creek south of Seward, transporting boulders as large as 8 feet in diameter (Lamke and Bigelow, 1988). The largest flood not caused by a debris dam release during the 1986 flood was 1020 cfs per square mile on Rudolph Creek (Jones and Zenone, 1988).

Water Quality

Water quality data are limited for the Salmon Creek analysis area. A small number of water quality samples were collected by the US Geological Survey on Lost Creek and a tributary of Bear Creek between 1950 and 1971 (US Geological Survey, 2011). A water quality monitoring program for Seward area streams known as the Citizens Environmental Monitoring Program was started in 2008 by the Resurrection Bay Conservation Alliance. These data meet Alaska State water quality standards (Alaska Department of Environmental Conservation, 2009).

National Forest lands within the analysis area are mostly undeveloped, and the water quality in these areas is generally unimpaired by human sources. Natural sources of turbidity occur in many streams as a result of glacial activity or mass wasting. Turbidities from glacial melting increase throughout the summer as the rate of glacial melting increases. Human-caused impacts to water quality that do exist have very little effect on water quality because of the localized nature of the impacts and the naturally high sediment loads in many of the streams.

On non-National Forest lands, sources of water quality impairment in the analysis area are prevalent along the Seward Highway corridor and on some of the developed lands between Bear Lake and Seward. Industrial, residential, and highway pollutants threaten surface water and groundwater on non-National Forest lands in the area around Seward. Specific concerns include hydrocarbons, sediment, fecal coliform, and industrial contaminants, but little water quality data quantifying levels of pollutants are available.

No streams in the watershed are listed on the State 303(d) list of impaired water bodies. However, Fourth of July Creek, Salmon Creek, and Spring Creek are listed by the Alaska Department of Environmental Conservation as “Category 3” water bodies (Alaska Department of Environmental Conservation, 2010). This classification indicates suspected pollution, water quality impairment, or impaired fish habitat, but data are insufficient to determine whether the State water quality standards are attained.

Vegetation and Ecology

A wide variety of plant communities occur in the Salmon Creek Landscape Assessment Area. These plant communities are shaped by an equally diverse array of processes including anthropogenic disturbance, natural disturbance, topography, and forest succession. The plant communities in the assessment area include shrub/scrub, evergreen forest, deciduous forest, woody wetlands, mixed forest, sedge/herbaceous, dwarf shrub, and wetlands.

Topography is a major factor affecting vegetation distribution. The landscape area is a large U-shaped glacial valley surrounded by rugged mountain peaks of rock, ice, and snow at higher elevations. Below the rock and ice, an alpine vegetation zone of graminoids and forbs exist. A shrubby transition zone dominates mid slope, which consists of alder and willow. Valley sides and bottoms are forested to approximately 1500 feet elevation.

Evergreen forests are generally Sitka spruce (Picea sitchensis), Lutz spruce (Picea x lutzii), a hybrid between white spruce (Picea glauca) and Sitka spruce, black spruce (Picea mariana), mountain hemlock (Tsuga mertensiana), or mixed spruce and hemlock stands. Deciduous forests include pure and mixed stands of cottonwood (Populus balsamifera), Kenai birch (Betula papyrifera var. kenaica), and aspen (Populus tremuloides). Mixed evergreen/deciduous stands include Kenai birch, several varieties of willow, spruce, and hemlock.

Table 7. Salmon Creek Analysis area Vegetation from USFS Land Cover Data

Vegetation	Acres	Percent
Shrub/Scrub (Alpine, Sub-Alpine)	14894	24
Evergreen Forest	14445	24
Perennial Ice/Snow	12615	21
Shadow	11278	19
Barren/Rock , Sand	3622	6
Developed	968	2
Open Water	893	1
Deciduous Forest	512	1
Woody Wetlands	475	1
Sedge/Herbaceous	445	1
Cloud	318	1
Mixed Forest	183	0
Dwarf Shrub	144	0
No Data	87	0
Emergent Herbaceous Wetlands	31	0

All successional stages are present in the landscape area but mid- and late-seral stages with spruce and hemlock dominate. Past glaciations, avalanches, seasonal flooding, wind events, insect and disease outbreaks, and occasional fires are the principal natural disturbances that shape plant communities within the assessment area. Glaciers have scoured sites and prepared them for primary succession, which is "succession…on sites that have not previously borne vegetation" (Helms 1998). Minor disturbances, including insect and disease related mortality, competition based mortality, wind throw, and floods are

drivers of secondary succession in this watershed. When these events occur, they generally create early-seral patches of deciduous species, or hardwoods (birch, aspen, cottonwood), within a stand that is in late-seral or climactic condition. Alternatively, minor disturbances may create small gaps that release mid- and late-seral species (spruce or hemlock) already present in the understory, permitting them to reach the canopy. Major disturbances cause the forested plant communities in this area to return to an early-seral forest type, which would include any of the hardwoods listed above including alder. In the assessment area, precipitation is higher than average which could change the typical succession pathways to favor spruce as an early-seral species.

Anthropogenic disturbance includes development, use and maintenance of recreation facilities, human-caused wildfire, and fire suppression. Development is a key disturbance around Resurrection Bay with part of the community of Seward, Alaska, existing in the landscape area. Development includes the Seward Highway and other roads, the railroad, and private residences and businesses. Use and maintenance of recreation facilities should be considered a minor disturbance, because the use does not replace the stand. Human-caused wildfire can be either a minor or major disturbance, but hasn't played a significant role in the landscape area due to higher levels of precipitation in comparison to other areas of the Kenai Peninsula. As a minor disturbance, it could create early-seral patches within late-seral stands. As a major disturbance, it would create entirely new stands of early-seral species. Fire suppression should be considered a process that shapes the landscape. As fires are suppressed or moisture prevents fire in the landscape, the trend of vegetation is toward late-seral species and forests and fewer large patches of early-seral forest.

Botany and Weeds

Ecosystems

The Salmon Creek Landscape Assessment area occurs within the Northern Pacific Maritime Biome, along the north and east shores of the Gulf of Alaska. The Northern Pacific Maritime Biome receives copious rain at lower elevations and snow at higher altitudes, coupled with relatively warm temperatures throughout the year. The warm, wet climate supports lush conifer rainforests along the coast and large ice fields and glaciers at higher elevations. The coastlands reflect their glacial heritage, with steep bedrock fjords, tidewater glaciers, and numerous rocky islands.

Non-native Plants

Non-native plants within the Salmon Creek Landscape Assessment area occur in areas of human disturbance such as along roads, trails and facilities. The City of Seward occurs in this watershed and contains numerous occurrences of non-native plants. Natural, undisturbed ecosystems are typically free of non-native plants.

Sensitive and Rare Plants

There are no sightings of any Region 10 Sensitive plant species within the landscape assessment area. This may be a data gap as very little of the watershed has been surveyed for sensitive plant species.

Fire and Fuels

The Kenai Peninsula is a transitional zone between boreal forests merging with the coastal rain forest. Sitka spruce thrives in the near coastal zone where climatic conditions limit the frequency and intensity of naturally occurring fires. Mountain hemlock is considered to occur as a subalpine forest, which usually burns infrequently; however, fire is the primary large-scale disturbance agent in these forests (Agee, 1989). White spruce is adapted to a wide range of ecosystems and climatic conditions and has a transcontinental range across Alaska where it overlaps with Sitka spruce near sea level (Burns and Honkala, 1990). Fire has played an integral role in the evolution and maintenance of the flora and fauna of northern circumpolar forest habitats. Throughout the range of white spruce, fire has been an important, sometimes dominant factor in forest dynamics. White spruce is probably more susceptible to destruction by fire than any other tree in Alaska (Lutz, 1953).

Fire has historically been present in this century in the Kenai Mountains but whether fire is the important disturbance process creating structural and landscape diversity within this ecosystem is unknown. There are three distinct areas of fire frequency: prehistoric (pre-1740), settlement (1741- 1913) and post-settlement (1914 to present). Forests on the peninsula had not sustained timber harvest prior to 1740. Uncut forests provide a rare opportunity to discern the natural dynamics of vegetation in an expanding landscape becoming dominated by both human and insect disturbances.

Aquatic Species and Habitats

There are four watersheds that are contained in this assessment unit: Box Canyon, Salmon Creek, Sawmill Creek, and 4th of July Creek. Collectively they represent 109 miles of stream habitat, 93 of which are located on Chugach Forest lands. In addition, the assessment area includes 919 acres of lake habitat and 782 acres of swamp and beaver pond habitat. At least 15 fish species have been confirmed or are very likely to exist in this area as listed in Table 8. However, a comprehensive inventory of aquatic species has not been made for these watersheds and the list provided here should be viewed as provisional until such work can be completed in the future.

Table 8. Fish species known or expected to exist within the Salmon Creek Landscape Assessment area.

Common Name	Family	Genus	Species
cutthroat trout	Salmonidae	Oncorhynchus	clarki
pink salmon	Salmonidae	Oncorhynchus	gorbuscha
chum salmon	Salmonidae	Oncorhynchus	keta
coho salmon	Salmonidae	Oncorhynchus	kisutch
steelhead (rainbow trout)	Salmonidae	Oncorhynchus	mykiss
rainbow trout	Salmonidae	Oncorhynchus	mykiss
sockeye salmon	Salmonidae	Oncorhynchus	nerka
Chinook salmon	Salmonidae	Oncorhynchus	tshawytscha
Dolly Varden char	Salmonidae	Salvelinus	malma
coast range sculpin	Cottidae	Cottus	aleuticus
prickly sculpin	Cottidae	Cottus	asper
slimy sculpin	Cottidae	Cottus	cognatus
Pacific staghorn sculpin	Cottidae	Leptocottus	armatus
threespine stickleback	Gasterosteidae	Gasterosteus	aculeatus
ninespine stickleback	Gasterosteidae	Pungitius	pungitius
Pacific Lamprey	Petromyzontidae	Lampetra	tridentata

Similarly, an adequate description of aquatic habitats within the assessment area is not possible because the necessary surveys have not been completed. Inferences can be made based on stream gradient and water source, but only in a general sense. As noted in the hydrology portion of this report, the gradient of streams in the Chugach Forest portion of the assessment area are steep and probably less than ideal for most indigenous species. In addition, the source of water for a large fraction of the streams is glaciers. As such, the water turbidity for much year is high and the stream channel is unstable and shifting. In general, these are not conditions typically associated with being good habitat for Salmonids. Probably the most productive stream systems in this basin are those associated with lakes.

Terrestrial Species and Habitats

Terrestrial habitats include a mosaic of wetland and upland habitats. Diverse vegetation types and structures provide diverse habitats for nearly 200 species commonly found on the Kenai Peninsula.

The majority of the area is rock/snow/and ice, which may have declined over the last 30+ years. Forests are mainly coniferous which have had little disturbance from fire or the spruce bark beetle and are mainly 200+ years old. Mixed, deciduous forests are very limited.

Forested areas are generally below 1,500 feet, and are primarily hemlock and spruce. Structure of the conifers is unknown, but most are likely mature or old growth, unless the areas have been disturbed by avalanche, flooding, wind throw or human caused disturbance. USFWS Land cover data also classifies forested areas as being 200+ years old. The spruce bark beetle impacts are less here than in other warmer and drier areas of the district possibly due to coastal climate. Old growth or mature forests provide potential nesting habitat for goshawks, neo-tropical migratory birds and raptors. They also provide thermal and hiding cover and denning areas for large mammals, travel corridors for moose, bear, wolverine, and wolves, and winter foraging areas for mountain goats. Some larger diameter and/or old growth mountain hemlock and Lutz spruce trees may be present on bench areas, lower slopes, and below ridge tops. Mountain hemlock dominates stands that occur on ridges and convex slopes, providing potential nesting habitat for goshawks, winter foraging habitat for mountain goats, and bedding areas for bear and moose. Canopy gaps with devil's club, steep slope areas with mountain hemlock and blueberry provide forage for bears. Mature mixed hardwood forest are very limited but support populations of migratory songbirds, such as thrushes and warblers. Early seral or stand initiation habitats (Oliver, 1996) provide feeding habitat for moose, wolves, snowshoe hare, lynx, and nesting habitat for neo-tropical migrants such as sparrows and warblers.

Salmon runs in Grouse and Bear Creeks and associated tributaries are important seasonal sources of food and support populations of many terrestrial species of wildlife, including brown and black bear, bald eagles, and wolves. The Chugach National Forest wetland map notes about 1518 acres of wetland habitats in the analysis area. The land cover data, which extends beyond the forest boundary, also notes numerous additional woody wetlands adjacent to Nash Road and near Fourth of July Creek. Wetlands provide important nesting and foraging habitat for sensitive species such as trumpeter swans, and other waterfowl. The wetland areas near Nash Road in Seward contain swan nests and a large number of bald eagle nests.

Wildfire, spruce bark beetle infestations, avalanches, flooding, and human activities affect wildlife habitat and influence the structure, distribution, and functions of habitat throughout the analysis area (See Section 4.7.2). The spruce bark beetle appears to have had little effect on conifer stands. Lack of hardwoods seems

to indicate a general lack of disturbance except in avalanche areas and in flood plains. Flooding occurs often on the lower part of the analysis area in and adjacent to Seward, affecting development and habitat.

The human activities that affect wildlife include float plane activity at Bear and Lost Lakes, small aircraft in route to the Seward Airport, motorized and non-motorized recreation use in summer and winter on and off existing trails by hikers, snowmachiners, and hunters. Development that affects habitat includes 968 acres (land cover data) which includes city and private development, private residences and businesses in or adjacent to Seward, utility and telephone corridors adjacent to the highway.

Heritage Resources

Prehistoric Period

Very little is known about the prehistory of the Salmon Creek watershed, likely due to a lack of cultural surveys in this area. At this time we can only speculate about the prehistoric use by synthesizing regional chronologies from surrounding areas.

Archeological and ethnographic data has documented prehistoric use on the Kenai Peninsula in the Early to mid-Holocene by Eskimo-type cultures (10,000 to 1,000 BP), and the Late Prehistoric (1,000 to 200 BP) periods. The Late Prehistoric is associated with the Dena'ina culture, who constructed villages containing large multi-family houses and underground cache pits for cold storage (Boraas 2002). The Dena'ina (Kenaitze Indian Tribe) still resides and is active on the Kenai Peninsula today.

Two types of Eskimos lived in different areas of coastal Kenai Peninsula, while Athabaskan Indians inhabited the upper Cook Inlet area and Copper River Delta. Of the Eskimos, the Chugach (Chugachigmiut) lived in and around Prince William Sound, while the Unixkugmuit had settlements along the south coast of the Kenai Peninsula from around Puget Bay at the western end of Prince William Sound to Cook Inlet, including Kachemak Bay (de Laguna 1967).

In prehistoric and early historic times, the bays around Seward sheltered Unixkugmiut settlements. Villages were tucked into convenient locations within the fjords or inlets. Nearly all of these settlements were abandoned at the time of the 1890 census report. A village called Yalik, in Yalik Bay, south of Seward, was still inhabited in 1880, as Ivan Petroff enumerated thirty-two people there in his report on the census. It was abandoned before the 1890 census.

The Eskimo of this region lived at a trade crossroads between the Northwest Coast Indians, the Eskimos of Kodiak and the west and north of Alaska, the Aleuts, and the Athabaskan Indians. These outside influences brought a varied fund of ideas into the local Eskimo culture. At one point in the past, Eskimo-type people apparently inhabited all of the Kenai Peninsula. Stone lamps of Eskimo manufacture have been found in several inland locations, including the shores of Kenai Lake, as well as along the coast. However, not long before the Russians entered the Alaskan scene, Athabaskan Indians moved onto the Kenai and Alaska Peninsulas and took up residence there. Whether the Eskimos were forced to the coast because of the Indian migration, or whether other factors had caused them to abandon the interior regions at an earlier date, is not known (Barry 1986).

The prehistoric use of the Salmon Creek drainage is currently not represented by sites with a prehistoric component. However, given the location as a trade crossroads between several cultures over a span of 10,000 years it is reasonable to believe that prehistoric sites may exist in this area. High-altitude sites associated with seasonal sheep, goat, or caribou hunting may also exist. One inventoried high-altitude

house pit site has been inventoried just north of the landscape assessment area on Falls Creek. The data suggests that while activity may have been concentrated along streams with salmon runs, and coastal hunting of sea mammals, dispersed activities may also have taken place in high-altitude environments and in areas of high-relief (Dumond 1977; Clark 1982).

Historic Period

The Russians staked their claim on Alaska in the mid eighteenth century, after the voyages of Gvozdev and Bering in 1732 and 1741, respectively (Black 2004). They occupied parts of the Kenai Peninsula until 1867.

Resurrection Bay was first entered by Siberian fur trader Alexander Baranov in 1792 during a scouting mission to establish a shipbuilding location in Alaska. It was decided that the tall, straight timber on Montague Island would be perfect building material, and that the inlet on the mainland would be the chosen location for the shipbuilding. Since the inlet had been entered by Baranov on Easter Sunday, it was called Voskresenskaya Gavan, or in English, Resurrection Bay. As the shipbuilding progressed, the Russians needed more iron and they prospected in the Kenai Peninsula Mountains for iron ore. According to historian Mary Barry, "It is said that the burned rocks along the Russian River are remainders from Russian iron smelting attempts. The iron ore was transported down along Resurrection River to the bay." (Barry 1986).

Joseph Cooper, of Kachemak Bay, reported finding gold on Cooper Creek in 1884. In 1880 or 1888, Alexander King, a native of Ohio, who had experience in prospecting and mining from time spent in the goldfields of California, discovered gold on Resurrection Creek (Tuck 1933:521). In 1888 Charles Miller staked the first claim on Resurrection Creek, two miles upstream from Hope. The discovery of gold on the east side of the mouth of Sixmile Creek in 1888, and at Bear Creek and Palmer Creek in 1894, (Tuck 1933:521) would lead to the location of claims on Mills, Canyon, and Lynx Creek in 1895 as the "first trickle of gold seekers came into Turnagain Arm from the Outside" (Barry 1997 [1973]:34).

The gold rush period is not represented by any particular sites in the Salmon Creek drainage, though activities during this period may have contributed to the features currently inventoried. Much of the mining during the gold rush period consisted of pick and shovel operations, which leave only a very faint archaeological presence.

After the gold rushes subsided, considerable prospecting and mining continued to take place on the eastern Kenai Peninsula, including some prospecting within the Salmon Creek drainage.

Modern Period

During the latter part of the twentieth century, the importance of mining and timber related industries have diminished. Recreation and tourism have come to supplant these industries, and have continued into the present.

The Salmon Creek drainage contains segments of the Seward Highway, Alaska Railroad, Iditarod Trail, and several recreational hiking trails.

Recreation

Seward was established in 1903. Early homesteaders settled in the Salmon Creek drainage north of Seward shortly thereafter. Access into the watershed was along the newly constructed railroad. In early years, use in the watershed, was limited to the lower reaches of Salmon Creek. Outdoor recreation, as it exists today, did not exist in the early settlement days. Such outdoor activities as hunting and fishing and the associated activities of hiking and camping were done more for subsistence purposes then for recreational activities. It was during World War ll that outdoor recreation took hold within the watershed. There are reports that troops from Fort Raymond in Seward hiked up into the Lost Lake area to hunt Ptarmigan. A ski hill at divided was also developed for the troops. This was in close proximity to the current Divide Ski Trails. Accesses into the upper reaches of the watershed were developed more for resource extraction then for recreational activities. The old Lost Creek Trail was developed as a mining access. The old South Fork Trail up to the base of Tiehack Mountain was developed to remove railroad ties cut from the Hemlock stands at tree line. A similar route was established up onto the bench of Mount Alice for tie removal and a sawmill site. Stacks of old railroad ties still remain along these routes. Access into the Lost Lake area was originally developed at Mile Post 6 of the Seward Highway. Timber and ties were taken off the land via this route. Later, in the 1950's the route was used to access Lost Lake for a potential hydro power source. A trail off the north end of Bear Lake, part of the current Iditarod Recreation Trail, was constructed by a CCC crew in the 1930's for timber removal and to open up the country. All of these routes were used for subsistence and eventually outdoor recreational use.

The amount of recreation use within the watershed adjacent to the road corridor grew quickly after the war. With its close proximity to Seward, any undeveloped lands have been used by Seward area residents for both subsistence and recreational pursuits. In the early 1960's the modern snowmachine came into existence. This greatly expanded winter access and winter recreation. Today the area is used extensively by recreationalist both in the summer and winter. The types of outdoor recreation activities taking place include hiking, fishing, hunting, trapping, mountain biking, horseback riding, camping, cabin use, boating, nature photography, wildlife viewing, dog sledding, berry picking, picnicking with families and friends, cross-country and backcountry skiing, snowboarding and snowmachining

Recreation use on National Forest Lands within the watershed is primarily concentrated in the Lost Lake Area. To a lesser extent recreational use occurs on National Forest lands in the mountains on the east side of the watershed. Extensive use, both motorized and Non-motorized use, also occurs on State of Alaska and Kenai Peninsula Borough lands in the lower elevations and around the lakes of the watershed.

Existing recreational facilities on National Forest System lands include the Lost Lake Trail and Trailhead, the Dale Clemens Cabin and access trail, a small portion of the Primrose Trail, the Iditarod Trail and the Forest Entrance sign at Mile Post 8. Known user routes or potential trails extend up onto Mount Alice, Tiehack Mountain, along Lost Creek and up onto Resurrection Peaks. Off of the National Forest there are several private campgrounds but no state or local recreation sites. Other sites or areas that are used extensively are the Bear Creek Weir for salmon viewing; Grouse Lake for winter ice fishing; Bear Lake for boating, skiing and snowmachining; and the flood plain of Kwechak (Glacier) Creek for ATV riding. The winter season (approximately December through April) supports a wide range of motorized and non-motorized activities. Motorized recreation activities on National Forest System lands are restricted to the west side of the drainage during the snow season. All other National Forest System lands are closed to motorized use during both the summer and winter seasons. Winter recreation is clearly dependent of the maritime weather influences. Rain instead of snow greatly reduces outdoor use. The Lost Lake area has become an extremely popular State snowmachine area. Motorized recreation vehicles are allowed on all State and Borough lands outside the city limits of Seward.

Key Issues and Questions

The following issues and key questions are important for management of the Salmon Creek Analysis area and provide a framework for the landscape assessment. Some of these questions address natural processes that provide a basis for evaluating other issues. Others are important management considerations and should be evaluated by a variety of resource specialists.

Lands

Key questions related to lands within the project area involve road or trail access to National Forest System lands and the role of land managers in flood control planning.

Issue: Access

Because most lands adjacent to the highway in the project area have been transferred to state, city, borough, or private ownership, access to National Forest System lands is a challenge in certain areas. The Revised Land and Resource Management Plan for the Chugach sets a goal that "legal rights of access exist to all National Forest System lands" and an objective that the Forest Service will "acquire rights-of-way, easements, fee simple title, or other interest in lands, as appropriate, to meet access needs."10

In general, when National Forest System lands in Alaska are conveyed to fulfill the entitlements of ANCSA or the Statehood Act, the United States seeks to reserve easements where public access needs exist. However, not all needs are anticipated at the time of conveyance. As a result, certain features located within the project area, such as the National Iditarod Historic Trail, will require the acquisition of rights-of-way to provide users of such features with access across nonfederal lands. Specifically, rights-of-way may be needed near the Nash Road Trailhead and the Bear Lake trailhead. Moreover, as discussed in the previous section, for Conservation System Units like the INHT, special management considerations apply, potentially requiring, e.g., rights-of-way that are appropriate for motorized access.

Questions:

- Has the Forest Service reserved sufficient rights-of-way to provide continued access to National Forest Lands in the project area?
- Are the special management considerations that apply to INHT as a Conservation System Unit consistent with Forest Plan goals or prescriptions for the project area? If not, what can managers do to mitigate impacts and promote desired conditions?

Issue: Flood Control

The project area is characterized by steep mountains and certain areas are prone to flooding. Flooding events affected the project area in 1986, 1995, and 2002.

[10] Revised Land and Resource Management Plan for the Chugach National Forest (May 2002) p. 3-9.

Questions:

- Which, if any, forest roads, trails, developed recreation sites or access points are susceptible to flooding?
- Given the likelihood of future flood events, are alternate routes to the National Forest available, should forest roads, trails, developed recreation sites or access points be affected?
- What can the Forest Service do to ensure the safety of staff and the public using forest roads, trails, and developed recreation sites in flood prone areas?

Geology, Minerals and Soils

Geology and Minerals

Issue: There are no key issues related to geology or minerals.

Questions

- There are no key questions related to geology or minerals.
-

Soils

Issue: There are no key issues related to soils.

Questions:

- How is mass wasting or erosion shaping the Analysis Area?
- How is Climate change impacting the Soil Resource?
- How is recreation use in the Analysis Area impacting the soils resource?

Hydrology

Issue: Human uses in the analysis area related to trails, roads, and development cause variable impacts to water resources. These impacts primarily occur on non-National Forest lands in the lower elevation areas.

Questions:

- How do roads, trails, development, and flood control structures in the Salmon Creek analysis area affect stream channel processes and water quality?
- What impacts do recreational uses in the watershed have on stream channel condition and water quality?

Issue**:** Naturally dynamic streams and frequent flooding in the area can potentially impact established recreational sites, roads, trails, bridges, and other developments. The majority of these impacts occur on non-National Forest lands in the low elevation areas.

Questions:

- How do natural channel changes and flooding affect roads, trails, bridges, and developed areas in the Salmon Creek analysis area?
- What is the flood history in the Seward area, and how are the flood frequency and flood hazards changing over time?

Issue: Climate change is likely to cause gradual changes in precipitation patterns, flood dynamics, and vegetation conditions within the analysis area, potentially affecting stream channel conditions, stream processes, and riparian composition. These potential long term changes are not well understood at this time, but will likely be a factor in resource management in the future.

Question:

- How are climatic trends affecting glaciers, stream flows, channel morphology, and water quality in the Salmon Creek analysis area?

Vegetation and Ecology

Issue**:** There are no issues related to vegetation and ecology.

Questions:

- What are the major succession processes or disturbance regimes at work on the landscape and how will a warmer drier climate change disturbance regimes?
- What is the current status of vegetation in relation to historic range of variability for the Quartz Creek area?
- What is the resistance of the stands to insect attacks: how can we maintain an endemic population vs. an epidemic outbreak?
- Based on the proximity to the port in Seward, what is the possibility of introduction of gypsy moth or other non-native insects and plants?
- How does Alder die-back effect succession?

Botany and Weeds

Issue: There are no issues related to botany and weeds.

Questions:

- How will climate change affect our ecosystems?
- To what extent should control of non-native plants and public education be a management priority?
- What sensitive and rare plants occur within the watershed and what are their habitat requirements?

Fire and Fuels

Issue: Spruce bark beetle infestation in the watershed may result in an increased risk of natural or human-caused wildfire, with associated degradation of air quality.

Questions:

- Will increased recreation use bring the likelihood of more human caused fires?
- Will the spruce bark beetle outbreak on the Kenai Peninsula, along with increased recreation use, increase the threat of wildfire impacting the Analysis Area due to unwanted ignitions?

Aquatic Species and Habitats

Issue**:** The aquatic species that utilize the Salmon Creek LA area have been poorly inventoried. Lacking is information on distribution, relative number, degree of demographic independence among putative populations, genetic/population sub-structure, intrinsic reproductive rate, and habitat utilization. Without this information it is difficult to assess the condition of the habitat relative to the production and sustainability of the indigenous populations.

Questions:

- Is the list of species presented in Table 8 accurate?
- How many or at what density do the aquatic species exist?
- Which habitats does each aquatic species use; what is their distribution within the assessment area?
- For each species found in the assessment area, does a finer level of sub-population structure exist as evidenced by genetic heterogeneity or identification of demographically independent reproductive units?

Issue**:** Large numbers of hatchery origin Chinook, coho, and sockeye salmon occur within the Salmon Creek assessment area. Nearly all of this fish, if they are not caught in fisheries, spawn in natural habitats alongside and probably interbreeding with indigenous wild members of the same species. If the proportion of these hatchery fish in the total spawning population of hatchery and wild fish is greater than 20% (which it most likely is) there could be an adverse impact on the genetic character and productivity of the natural population. This could translate into fewer wild fish and an impairment of the population to genetically adapt to changing climatic conditions.

Questions:

- Where do hatchery fish spawn in the assessment and in what numbers relative to wild fish?
- Are there ways to divert hatchery fish from natural spawning areas, while preserving the current size of the hatchery program and associated fishery benefits?
- Are the adverse ecological impacts (predation and competition) of these hatchery fish on other aquatic species significant?

Issue: Based on the fishery data, numbers of Chinook salmon and Dolly Varden char may be decreasing. It is unknown if a similar trend also exists for the total run (catch plus spawners) or whether it applies to these species in the assessment area. Further it is unknown whether this decline poses a conservation risk to continued persistence and sustainability of these species.

Questions:

- What is the total run size (catch plus escapement) of Chinook salmon and Dolly Varden char that are naturally produced in the aquatic habitat of this assessment area?
- What is the likelihood that either of these two species is failing the sustainability test?

Issue: Very little is known about the aquatic habitat in this assessment area in terms of its ability to produce fish. What is needed is a comprehensive inventory of the available habitat. From this it would possible to identify the key production areas for each species, locations where habitat needs restoration because of past human impacts, and other locations where there may be opportunities to enhance the existing habitat with the purpose of producing more fish.

Questions:

- What is the intrinsic productivity of the diverse aquatic habitats in the assessment area and how does this vary among the species? This question would be directed at all aquatic species and not just salmon.
- What are the core production areas within the assessment area for production and sustainability of each species?
- In what areas or locations are there opportunities for habitat restoration or enhancement?

Issue: In recent years, the air temperatures in this region have increased due to climate change. These increases are likely to continue into the future. This will likely impact the freshwater and marine environment in ways that are difficult to predict. Within the freshwater, warming air temperatures may reduce or eliminate glaciers as a hydrologic feature over a portion of the landscape. In addition, greater proportions of the basin may receive precipitation mainly in the form rain rather than as snow. These changes may alter the distribution and abundance of aquatic species in way that places a heavier burden on Chugach Forest lands as the primary production areas. For planning purposes and implementation of stream habitat restoration /enhancement projects it would be useful to know the range of likely possible outcomes in terms of changes in fish habitat as climate change occurs.

Questions:

- How much will climate change impact the hydrology of the assessment area streams – both spatially and seasonally?
- Is it possible to predict the impact of different climate change scenarios in terms of which areas are likely to become more important to aquatic species and which areas less so?
- Given the climate change predictions, are there unique stream restoration/enhancement opportunities that are actionable now or in the near future?

Terrestrial Species and Habitats

Issue: Development and Human Uses: How are human uses such as motorized and non-motorized recreation sites, trails, roads, aircraft and weirs affecting wildlife and habitat? Is wildlife or their habitat needs in conflict with human uses, or human uses impacting wildlife and habitats?

Questions

- What are effects to brown bears in the analysis area? Why are DLP's (defense of life or property increasing?
- How much snow machine and aircraft traffic occurs in alpine areas (Lost Lake, Godwin Glacier) and is it influencing movements of goats and wolverines and other species?
- How much development is planned, how much habitat loss will occur, how will development affect the functioning of wetlands and habitat connectivity?

Issue: Climate change may affect species and their habitats over time particularly alpine species.

Questions

- What are the trends or expected changes for alpine vegetation?
- What are the current nutritional condition, and health, and population trends of Dall sheep and mountain goats?

Heritage Resources

Issue: There are no key issues identified.

Questions:

- There are no key questions identified.

Recreation

Issue: Different jurisdictions lead to different management activities, goals, philosophy or objectives.

Questions

- How does the public know what is permissible on the different public lands in the watershed?
- Where are the boundary between National Forest System lands and State lands?
- Do we have clear direction on how we manage Federal easements through borough and state lands?
- How do we deal with uses legally occurring on State lands that continue on to the National Forest?

Issue: There is a need for recreation use data, particularly in the winter that crosses property boundaries.

Questions:

- How do we collect that data?
- How do we share that data?

Issue: Management of recreation use (non-motorized/motorized use) across jurisdictions.

Questions:

- How do we identify land jurisdictions?
- How do we manage such use?
-

Issue: Land plans and/or regulations that may displace users.

Questions:

- Where do these displaced users go?

- What affects are there on adjacent lands.

Current Conditions

This portion of the landscape assessment discusses the current range, distribution, and condition of resources within the Salmon Creek Analysis area, and provides a summary of all information relevant to the issues and key questions known about the analysis area.

Lands

Approximately 63% of the project area is National Forest System land. Section 6(a) of the Alaska Statehood Act of July 7, 1958 (P.L. 85-508) authorized the state to select lands from within the National Forests for community development, expansion, and recreation. For the most part, state-selected lands within the project area are concentrated near the road and rail system. There is little fragmentation of National Forest System lands elsewhere in the project area.

In 2010, the Natural Resources Conservation Service partnered with the Kenai Peninsula Borough to provide a voluntary acquisition project for flood mitigation that included properties located in the Old Mill Subdivision. The Forest Service acquired some of these properties for habitat purposes. It is unknown whether the Forest Service will participate in similar projects in the future.

The Forest Service may seek to acquire additional rights-of-way to support recreational development, however, no major changes in land status conditions are anticipated for the project area.

Geology and Minerals

Minerals

Types of minerals administered by the Forest Service includes locatable minerals (36 CFR 228, Subpart A), salable minerals (38 CFR 226, Subpart C), leasable minerals (36 CFR 228, Subpart E), and reserved and outstanding minerals (36 CFR 251.15, FSM 2830). Locatable minerals claimants and operators have a statutory right to develop the mineral resource under the 1872 Mining Law. The disposal of salable minerals is a discretionary action. The Forest Service may determine whether to offer mineral material sales and administer disposal under the salable regulations cited above.

Locatable Minerals – No current plans of operations exist in the analysis area. The submission of additional proposals for mining is difficult or even possible to predict.

The U.S. Geological Survey assessed the mineral resource potential for the Chugach National Forest for the Forest Plan revision (Nelson and Miller 2000). The report focused strictly on metallic mineral resources. It did not cover leasable resources such as coal, oil and gas, or salable resources such as common variety rock, gravel, and sand. The four deposit types evaluated are as follows: 1) Cyprus-type massive sulfide (copper, lead, zinc, gold and silver); 2) Chugach-type low-sulfide gold quartz veins (gold and silver); 3) placer gold; and 4) polymetallic veins (copper, zinc, lead, gold and silver).

Resource Tracts

About 62% of the analysis area is administered by the Forest Service and is mapped for Mineral Potential as follows: 2% is "Identified as Most favorable, Developable" (1,282 acres); 52% is "Identified as Moderately Favorable" (32,217 acres); and 46% are not coded/no data (28,151 acres). The Kenai Lake resource tract is defined by the presence of identified resources of gold from both placer and Chugach-gold deposits (Nelson and Miller, 2000).

Prospects and Occurrences

Locatable Minerals – Jansons et. al (1984) and others described mineral occurrences on the Chugach National Forest in 1984. Eleven different resource locations were documented in the watershed but only six are on NFS lands but only three of the occurrences are worthy of mention and includes S-195: Godwin, a massive sulfide vein that was not visited during the study; S-205, Brewer Alaska Syndicate, which includes three adits on a gold/silver bearing vein; and S-209, Mizpah Ledge of the Kennedy-Pullen-Davis, one adit at a high grade but ultra-low tonnage gold bearing shear zone.

Salable Minerals (Mineral Materials, Common Variety Minerals) - According to the geology map several significant Quaternary deposits (sand and gravel) occur within the valley floors of the analysis area. The Bureau of Land Management surveyed mineral material sites on the roaded corridor of the Chugach National Forest (Sherman, et al., 1997) for various mineral materials but did not identify any sites in the analysis area. Additional sand & gravel and rock needs may be identified in the future for development at the discretion of the authorized officer. Quality rock is in short supply and can be in high demand in and near the assessment area for general fill, road construction, riprap and other construction purposes.

Leasable Minerals - There is low or no potential for oil and gas, and coal deposits in the analysis area.

Soils

The National Forest Lands are in a near-natural state. Erosion rates and mass wasting rates are at near-natural levels due to the absence of management. Although the rate of mass wasting is unknown in the Analysis area, there are no known management-related failures. Though natural, the landslides in Box Creek have a tremendous impact on the stream morphology. A large landslide has dammed the channel in the past, causing flooding.

Since 1950, glaciers across Alaska have thinned at an average rate of 1.8m/year (Arendt et al. 2002). This thinning exposes rock and sediments around the entire perimeter of the glacier. Vegetation colonization and soil development are occurring on new glacial sediments throughout the project area. This is expected to continue at an increasing rate in the future.

The existing impacts are from recreation and motorized use in both summer and winter. Several, small fires occur along the highway and rail road but there isn't a history in the National Forest Lands. Timber and fuel management is absent as well.

Summer motorized use is limited to designated trails except for subsistence use in the northwest portion, which includes Long Lake. The population with subsistence rights is a rather small so the impacts from these few are minor. Several trails begin on the non-National Forest Lands and extend onto National Forest Land. These are considered unauthorized trails on National Forest Land. Development: especially the user-created trails starting on NNFS land but continuing onto NNFS lands.

More area is open to winter motorized use than summer use. The entire northwest third of the project area (Box Creek and Lost Lake) is open to motorized use. Generally the impacts of snowmachines running over snow do not impact soil resources. The trail to lost lake can become eroded due to snowmachines running over soil rather than snow. In these cases, the trail is closed until enough snow cover will support traffic.

There is increased camping around Lost Lake. There isn't an established facility there but there are more users camping along the shore.

Hydrology

Analysis of current conditions in the Salmon Creek analysis area focuses on the National Forest and non-National Forest portions in order to provide an overall view of watershed processes. Water resources on National Forest lands within the Salmon Creek analysis area are minimally impacted by human uses and are generally in their natural conditions, as much of the area is relatively inaccessible backcountry. Non-National Forest lands in the central portion of the analysis area include the highway and railroad corridor, as well as the highly developed areas around Seward.

Geomorphologic Trends

Valley morphology, stream channel morphology, and morphologic processes in the Salmon Creek analysis area are primarily controlled by glacial processes, high relief terrain, and high precipitation. High sediment loads from glacial sources control the channel morphology of the streams in the southern half of the analysis area. Extremely high stream flows per square mile of drainage area, resulting from steep watersheds and high precipitation, result in frequent dynamic channel changes in most streams in the analysis area.

Glaciers in the watershed have been receding and thinning for over 200 years. The two prominent glaciers in the analysis area are the Bear Lake Glacier and Godwin Glacier. Analysis of aerial photography between 1961 and the present show considerable recession and thinning of these glaciers (Figure 16). Molnia (2008) described accounts of the Bear Lake Glacier receding a total of 515 meters between 1957 and 1996, along with an average of 9.7 meters of thinning. This represents an average glacial retreat of 13 meters per year. Godwin Glacier has been less intensely studied, but shows similar rates of glacial retreat. Based on aerial photo comparison, Godwin Glacier experienced as much as approximately 600 meters of recession between 1961 and the present, or an average of 12 meters of recession per year.

As these and other glaciers in the analysis area recede, raw areas of exposed glacial till are exposed and gradually become colonized by vegetation. Although additional sediment is made available to these stream systems as the glaciers recede, the ultimate trend is decreasing sediment loads as the glaciers become less active, produce less sediment, and are replaced by vegetative cover. Changes in stream channel morphology in these streams are likely to occur over a long time frame (centuries) as a result of

these changes in sediment loads, but the ultimate trend is increased stabilization of the stream channels downstream.

Glacial and non-glacial streams in the analysis area produce large amounts of sediment as a result of the high relief, raw mountain slopes, and deeply incised canyons. Natural landslides, avalanches, and other mass wasting processes deliver abundant sediment to these stream systems. The result of these processes and glacial sediment delivery is the constant aggradation of the valley floor in the low gradient reaches of these streams. Alluvial fans have been increasing in size and height for thousands of years. Stream channels on these alluvial fans are typically dynamic, constantly changing course to adjust to sediment deposition.

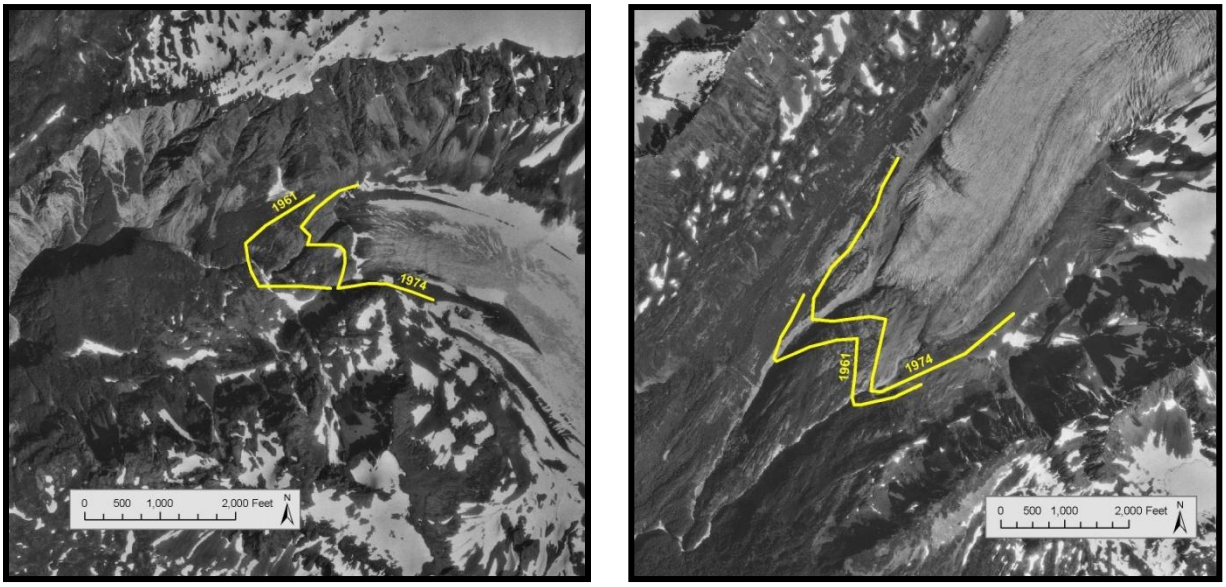


Figure 16. Recession of the glacial terminus of the Bear Lake Glacier (left) and the Godwin Glacier (right), based on comparison of aerial photography from 1961, 1974, and the present (base photo is recent ortho-photography).

Human Impacts to Water Resources

Impacts to water resources from human developments are relatively limited on National Forest lands within the Salmon Creek analysis area, whereas numerous impacts occur on non-National Forest lands in the lower elevation areas around Seward and along the Seward Highway/Alaska Railroad corridor. Human impacts to water resources in these lower elevation areas include physical stream channel alterations and potential water quality impacts related to development in the area. Recreational uses have had limited effects on water resources in the analysis area.

Human impacts to the natural course of stream channels are widespread, primarily on non-National Forest lands throughout the analysis area. Flood control berms and levees are present on a number of streams to protect roads and subdivisions from bank erosion and dynamic channel changes. As a result, many floodplain areas are cut off, restricting the natural ability of streams to dissipate energy and deposit sediment in the floodplains.

Levees have been constructed at the apex of the Box Canyon Creek alluvial fan since at least the 1980s to prevent flood flows from inundating the Exit Glacier Subdivision in the historic floodplain to the southeast and to direct Box Canyon Creek beneath the Exit Glacier Road and into Resurrection River (Figure 17). Because this is an alluvial fan system that transports large amounts of sediment, this levee requires constant maintenance after flood events to maintain its function. Continued aggradation further increases maintenance needs and the risk of high flows overtopping the levee. A portion of this levee lies on National Forest lands.

On non-National Forest lands, similar levees have been constructed at the mouths of the canyons of Kwechak Creek and Fourth of July Creek, and in places along Lost Creek to protect the Seward Highway and local roads. Active glacial or high sediment load streams that flow adjacent to subdivisions or developed areas create challenges as bank erosion advances towards roads and property, requiring expensive stabilization efforts. This occurs along the lower portion of Fourth of July Creek and along Kwechak Creek near Bear Lake.

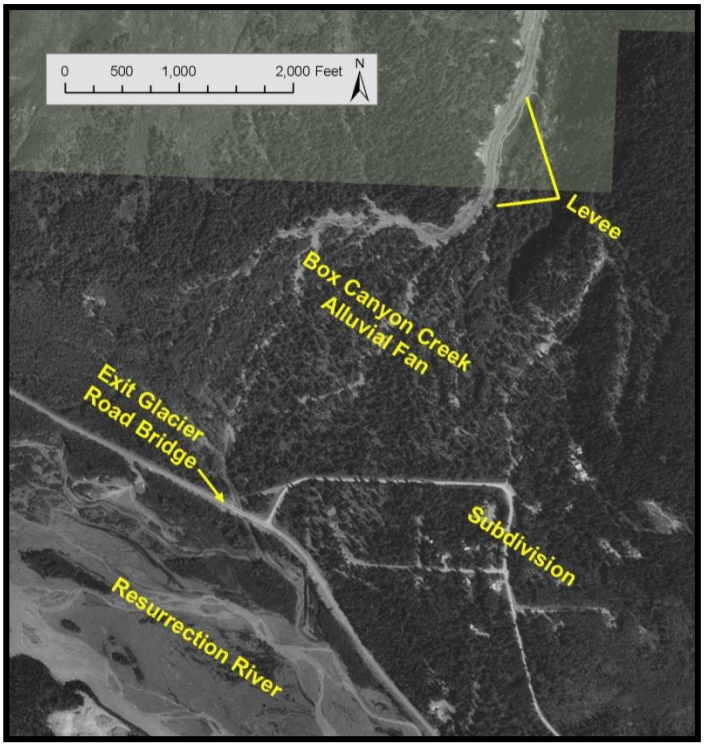


Figure 17 Box Canyon Creek levee and alluvial fan.

This channel has historically migrated east across the alluvial fan and into Clear Creek instead of under the road and into the Resurrection River. National Forest lands are highlighted.

Additional stream course modifications are present on non-National Forest lands at the mouth of Salmon Creek, where a gravel berm is maintained to keep the flow in Salmon Creek distinct from the flow in the Resurrection River. Although Salmon Creek enters the wider outwash plain of the Resurrection River about 1 mile upstream of its mouth, Salmon Creek does not intermix with flow from the Resurrection River at normal flow levels. The sixth-level watershed boundaries drawn between Outlet Resurrection River (190202020508) and Salmon Creek (190202020507) could be modified to reflect this configuration

(Figure 18). It makes little sense to include the wedge of land between Salmon Creek and Sawmill Creek as part of the Outlet Resurrection River watershed, when the outlet of Salmon Creek is actually at the head of Resurrection Bay.

Grouse Creek flows along the Seward Highway on non-National Forest lands upstream of Grouse Lake. In order to protect the highway, a large flood overflow channel was constructed on the west side of the highway to provide flood relief for the Grouse Creek channel, which is constrained along the east side of the highway.

The analysis area includes numerous bridges and culverts where roads and railroads cross streams. These crossings are almost exclusively on non-National Forest lands in the Seward area and along the Seward Highway/Alaska Railroad corridor. These crossings control channel location and in some cases impact channel morphology by constricting the channel width or creating barriers to flow and passage of aquatic organisms. Culverts can clog with debris and exacerbate the effects of floods. The Alaska Department of Fish and Game has classified 3 "red" culverts (conditions assumed inadequate for fish passage) and 4 "gray" culverts (additional data collection and analysis needed) in the analysis area (Alaska Department of Fish and Game, 2011). The Kenai Watershed Forum and Resurrection Bay Conservation Alliance are working to replace problem culverts in the analysis area with more suitable structures.

Figure 18. A gravel berm is maintained to prevent Salmon Creek and Resurrection River from joining during normal flow levels. The 6th-level watershed boundaries (outlined in yellow) could be modified to reflect this configuration.

Recreational uses in the analysis area have minimal impacts on water resources. Glacial channels such as Kwechak Creek are not highly sensitive to impacts from stressors such as bank trampling because of the high sediment loads and high natural bank erosion rates. Streams in the area receive low to moderate fishing pressure, and angler trampling from fishing access is not a large concern. The largest impacts on

streams from recreational use are in areas of close proximity to Seward and the Seward Highway corridor. For the most part, recreational uses are more dispersed on the National Forest lands in the watershed. However, notable localized impacts to the riparian area and banks along Lost Lake are starting to occur as a result of increased use and dispersed camping.

Human impacts to wetlands in the analysis area are almost exclusively on non-National Forest lands. A few trails and concentrated use areas impact wetlands on National Forest lands, but these impacts are small scale and localized. Numerous impacts have occurred to wetlands on non-National Forest lands in floodplain areas in the valley floors, caused by development and roads. The lack of developable land in the Seward area is the primary reason why development has occurred in sensitive wetland and floodplain areas. The proposed Seward Area Wetlands Functional Assessment Project and the Seward Area Suitability Mapping Project will better inform proper development in these sensitive areas around Seward (Kenai Peninsula Borough, 2010). These projects represent a partnership between the Kenai Peninsula Borough, the Kenai Watershed Forum, the Seward/Bear Creek Flood Service Area, and the Resurrection Bay Conservation Alliance to produce a wetlands management plan for the area, map flood hazards and channel migration zones, and compile recommendations for development in floodprone areas.

Water uses in the analysis area are limited. The analysis area contains no municipal watersheds for consumptive use of surface water. Seward derives its drinking water from groundwater sources, and these aquifers are recharged by rainfall and snowmelt runoff within the analysis area. No dams or diversions exist in the analysis area, and hydropower is not produced. A hydropower project was once proposed for Lost Creek and Lost Lake, but no such project was ever developed.

Human impacts to water quality are limited on National Forest lands in the analysis area because of the lack of development and dispersed levels of use. Localized impacts occurring as a result of concentrated recreational uses may have very minor impacts on water quality in nearby streams. Some of these impacts include erosion from dispersed camping along Lost Lake, erosion on the lower portion of the Lost Lake Trail as a result of winter snowmachine use during low snow conditions, and erosion along steep grades and wetlands on the Lost Lake winter trail to the Dale Clemens Cabin.

Water quality impacts on non-National Forest lands in the analysis area are widespread. Although data are limited, water quality can be affected by numerous impacts in the Seward area and along the Seward Highway corridor. Hydrocarbon and chemical spills are possible along the Seward Highway and Alaska Railroad. Runoff from roads and developed areas delivers sediment, winter sanding gravel, and potentially other pollutants to nearby streams. The Resurrection Bay Conservation Alliance (RBCA) is currently conducting a Citizens Environmental Monitoring Program (CEMP) to monitor temperature, dissolved oxygen, pH, conductivity, and turbidity at a number of sites in the analysis area. The final report from 2008 and 2009 describes 4 sites within the analysis area (Resurrection Bay Conservation Alliance, 2009), and additional sites are currently being measured. Results as of 2009 showed no definitive water quality issues.

Impacts of Channel Changes and Flooding

Impacts to human developments associated with channel changes and flooding in the Salmon Creek analysis area occur primarily on non-National Forest lands, where extensive development has occurred in floodplains and other low topography areas (Figure 19). Increased magnitude and frequency of flood events as a result of changing climate is resulting in more and more problems associated with flooding, particularly as development continues to occur in floodprone areas. Recent major flooding episodes in the Seward area have occurred in 1986, 1989, 1995, 2002, and 2006 (Seward/Bear Creek Flood Service Area,

2010a). Seward/Bear Creek Flood Service Area (2010b) provides a history of flooding in Seward between 1903 and 2009.

Figure 19. October 2002 flooding in a residential area on Salmon Creek along the Seward Highway

The floods of October 1986 occurred after a storm dropped over 15 inches of rain on the Seward area over the course of 24 hours (Jones and Zenone, 1988). A landslide temporarily dammed Box Canyon Creek in its narrow canyon, causing a large outburst flood to occur once the dam released (Jones and Zenone, 1988; Department of the Army, US Army Engineer District, Alaska, 1992). This flood broke through the levee and washed out the Exit Glacier Road, and Box Canyon Creek re-occupied an abandoned channel connecting to Salmon Creek through developed areas to the east. Because of its high sediment loads and potential for flooding, particularly with the potential for additional landslide dam-burst floods, maintaining this levee to keep Box Canyon Creek from flowing into developed areas has been a challenge that requires continual resources.

Minimal impacts associated with flooding and channel changes have occurred on National Forest lands in the analysis area because of the lack of development and the fact that these lands are mostly in upland areas. Frequent flooding events in the analysis area often cause inundation of city, borough, state, and private property in the Seward area. Development exists on the alluvial fans of Lost Creek, Box Canyon Creek, Sawmill Creek, and Fourth of July Creek. These alluvial fans are all fairly active because these streams generally carry high sediment loads during floods. Dynamic channel shifting can occur at the apex of an alluvial fan, causing new channels to develop far from the previous active channel. Flood events often result in emergency construction of levees to protect property, as well as extensive work to remove sediment and debris that has been deposited in developed floodprone areas. Flooding in the Seward area also causes physical loss of property and damage to roads, the railroad, and other infrastructure. Impacts to water quality during flood events can include the release of oil, gas, and other toxic chemicals associated with urban and industrial development.

Efforts are underway to mitigate some of the effects of flooding in the Seward area (Seward/Bear Creek Flood Service Area, 2010a). Removal of debris and bedload from key areas may help temporarily increase bedload conveyance and reduce the impacts of flooding, although it is not a permanent solution, it may be expensive, and it may result in additional channel adjustments that are not desirable. Keeping culverts clear of debris can help prevent damage to roads and property. Collecting hydrologic information about channel processes on many of the area streams will help inform additional mitigation measures.

Sediment transported by Kwechak Creek and other tributaries to Salmon Creek accumulates in the lower reaches of Salmon Creek. This aggradation of the Salmon Creek channel increases flood risk in these areas, and the situation is made worse by constraints on the channel such as bridges and levees that prevent the stream from utilizing the floodplains for sediment deposition. The Seward/Bear Creek Flood Service Area (2010a) recommends periodic bedload removal from Salmon Creek and the lower end of Kwechak Creek based on a 2008 sedimentation study by Northwest Hydraulic Consultants. Artificially restricting natural channel migration on these systems is causing stream bed aggradation in the channels, but not on the floodplains, thereby increasing the risk of flooding on developed areas within the floodplains.

Limiting development in floodprone areas is the most effective way to mitigate the effects of flooding in the area. This is difficult because much of the existing development is located on alluvial fans of active, high bedload stream channels, and few alternate locations exist for construction. The Kenai Peninsula Borough recently updated the floodplain maps for the Seward area. A March 2009 ordinance enacted the Seward Mapped Flood Data Area (SMFDA), based on inundated areas from the 1986, 1995, and 2006 floods (Kenai River Center, 2010). Federal Emergency Management Agency (FEMA) flood insurance rate maps, last revised in 1981, were also recently updated using 2006 data and released to the public in 2010. Although updated floodplain data will better regulate development in floodprone areas, the FEMA flood insurance rate maps may not reflect the current situation (Zemach, 2010) in part because frequent changes in flood elevations as a result of sediment deposition or scour are not always reflected on the most recent floodplain mapping. LIDAR data acquired in 2006 and 2009 for the area will be valuable for future updates of floodplain maps.

Climate

The climate of the Kenai Peninsula has been warming over at least the last several decades, a trend that is consistent with much of Alaska and other areas worldwide. Between 1949 and 2009, the mean annual temperature has increased by 3.0 degrees F in Anchorage, and 3.8 degrees F in Homer, with an average 3.0 degree increase statewide (Alaska Climate Research Center, 2011). Based on these datasets and the fact that coastal areas are seeing smaller temperature increases than interior areas, it is likely that the mean annual temperature in the Salmon Creek analysis area has increased by 2 to 4 degrees F in the last 60 years. The largest seasonal temperature increases are the winter temperatures. Over the same time period, average winter temperatures have increased 5.9 degrees F in Homer, 5.8 degrees F in Anchorage, and 5.7 degrees F statewide (Alaska Climate Research Center, 2011). The degree of changing climate in the Salmon Creek analysis area is moderated by the marine influence of this coastal area. Climate warming and its effects in this watershed are likely less than what is observed in portions of the interior Kenai Peninsula, where annual precipitation is lower.

The effects of climate change on water resources in the Salmon Creek analysis area are not easily quantified, and data are not readily available to quantify or predict changes in hydrology. However, climate change has had and will continue to have effects on the hydrology of the analysis area. Perhaps the most dramatic hydrologic change occurring with climate change is accelerated melting of the glaciers

and ice fields in the southern half of the analysis area over the last several decades. Other hydrologic changes associated with climate change include increased peak flows and increased flood frequency related to rain-on-snow events. Warmer winter temperatures are leading to more frequent winter rainfall. Changes in water quantity will be difficult to quantify in the streams in the analysis area because only one stream gauge is currently in operation. Changes to vegetative patterns in the watershed as a result of climate change are likely to be less dramatic than inland areas, and these changes are likely to have little effect on stream processes. Spruce bark beetle impacts are not common in this watershed because of the high annual precipitation and marine-influenced climate.

Vegetation and Ecology

To properly understand current conditions of the vegetation in the Salmon Creek Landscape Assessment Area, one must first understand the successional pathways and disturbance regimes of south central Alaska. Disturbance is defined as "any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment" (Helms 1998 p.49). Disturbance on the landscape is described by the amount of over story removal. Major disturbance is described as stand replacing disturbance, whereas minor disturbance leaves some remnant over story trees (Oliver and Larson 1996). Both of these types of disturbance shape the landscape in the assessment area.

Past glaciations, avalanches, seasonal floods, wind events, and occasional fires could all be major disturbances in the landscape area. Following a major disturbance, the typical successional pathway in the Chugach National Forest would be for deciduous species, or hardwoods (birch, aspen, cottonwood, alder, and willow), to initiate the new stand, then Lutz or Sitka spruce would typically begin growing in the understory. The hardwoods are fairly short-lived, and as they succumb to mortality, spruce becomes a dominant species in the forest canopy. In the assessment area, precipitation is higher than average which could change the typical succession pathways to favor spruce as an early-seral species.

Spruce may remain as the dominant species in the canopy for a number of years, but when influenced by endemic levels of insects or disease, often the least vigorous and largest diameter trees succumb to mortality, which creates gaps in the canopy. Mountain hemlock is generally present growing beneath the spruce canopy and can persist in the understory for long periods of time until it is released by a gap created in the canopy. When the gap is created, hemlock begins responding to the increase in light and will eventually grow to become a part of the canopy. Hemlock eventually can become the dominant late-seral species. In some stands, however, edaphic and climatic conditions are such that late-seral species may never become dominant and spruce will remain the dominant species. In higher elevations, hemlock is often the colonizing tree species creating pure stands of hemlock in all stages of succession.

One of the most important biotic disturbance agents causing a shift in canopy dominance from hardwoods to spruce is stem decay. Stem decay fungi alter stand structure and composition and appear to be important factors in the transition of even-aged hardwood forests to mixed species forests. Stem breakage of hardwoods creates canopy openings, allowing release of understory conifers. Among the conifer species, the principal biotic disturbance agent continues to be the spruce bark beetle (Dendroctonus rufipennis) which affects spruce. Other biotic disturbance agents include other bark beetles, animals, people, various rots, and occasionally defoliators. These other biotic disturbance agents are a small contributor to change within stands of softwoods in this area.

Abiotic disturbance agents are constantly at work and affect a wide variety of stands. Avalanches generally follow avalanche chutes and act on a stand to maintain shrubs or early seral hardwoods in a stand. Wind generally causes disturbance in mature stands. Fire generally has the most significant effect on spruce stands. Seasonal flooding may affect any stand within the flood plain of a stream or river.

Botany and Weeds

Ecosystems

Ecologists on the Kenai National Wildlife Refuge have been studying aspects of climate change (Morton, 2010). The Salmon Creek Landscape Assessment area is included in their analysis and will be discussed within the context of their larger study. Due to the nature of the data and scale at which the data was used, no attempt was made to extract their data for the only the Salmon Creek area. The data is too broad and interpretations would be taken out of context if we were to analyze the Salmon Creek area alone. Instead, the entire Kenai Peninsula is depicted with the general area of Salmon Creek circled in the Figure 20.

Ecologists at the Kenai Wildlife Refuge modeled existing vegetation, which was compared to an existing landcover classification map using LANDSAT imagery. Based on the model output, the existing vegetation within the Salmon Creek Landscape Assessment area consists primarily of mountain hemlock and spruce in the valley bottoms. Alpine vegetation dominates the side slopes with snow/ice covering the highest peaks.

Non-native Plants

In general non-native plants on the Chugach National Forest are restricted to areas of human disturbance and have been observed in Kenai Peninsula surveys (Duffy 2003). Important factors affecting non-native plant populations appear to be the high level of human use, the diversity of human use (including the use of pack animals, mountain biking and other means of mechanical recreation), and the change in natural communities due to road construction, and re-vegetation projects. All of these factors are projected to increase over time.

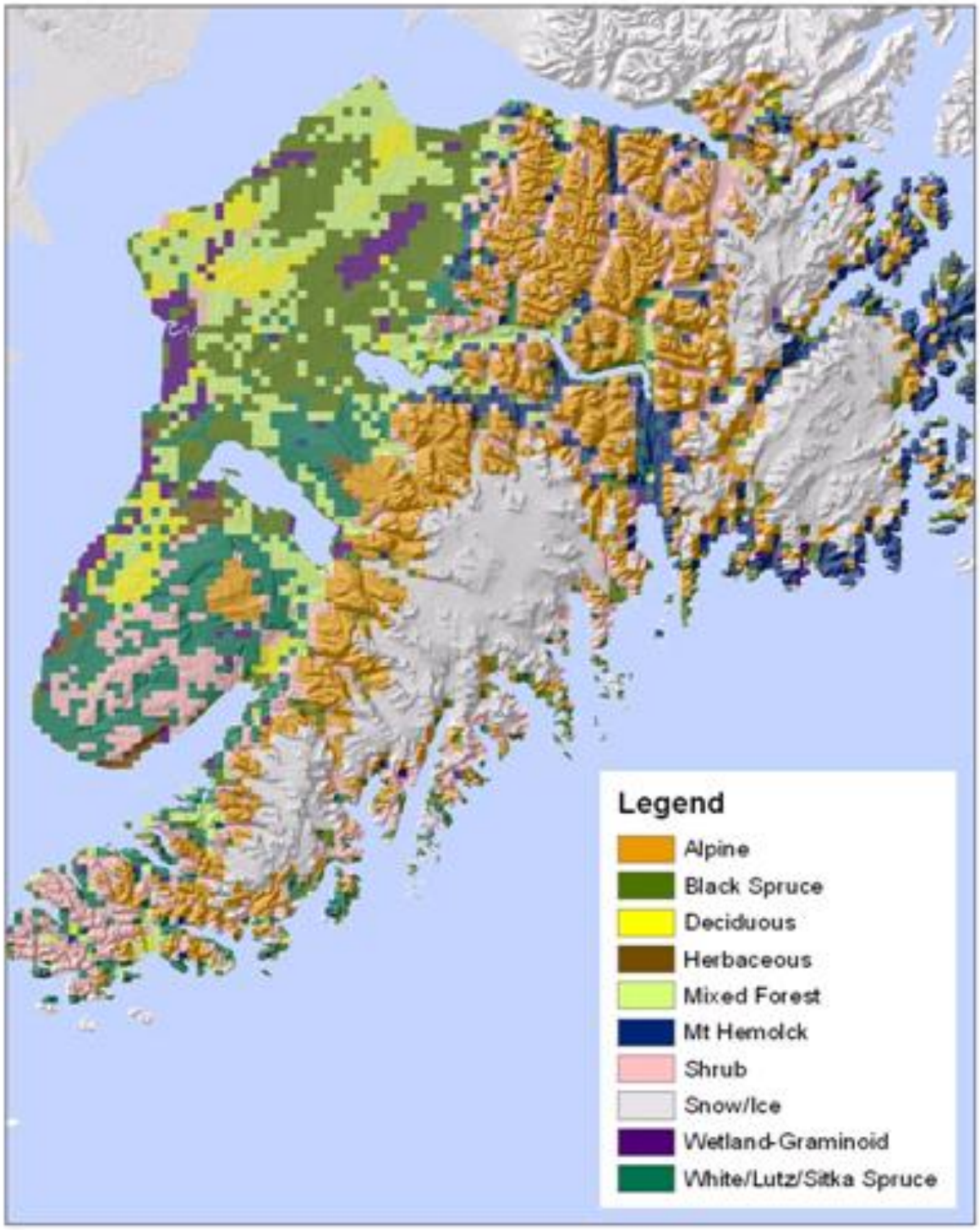


Figure 20. Kenai Peninsula Vegetation (LANDSAT)

Figure 21. Non-Native Plant Records

Inventories for non-native plants within the Salmon Creek landscape area have taken place in select areas over the past 10 years. Past inventories include roads, trailheads and trails and have focused on areas of human disturbances, which is where most non-native species are found. A large part of the Salmon Creek landscape area remains undisturbed by human activities and should be free of non-native species. Areas of human disturbance include roads (City of Seward, Seward Highway and Exit Glacier Road), trails and trailheads (Lost Lake Trail), and other developments. Figure 21 shows locations of non-native plants from various inventories.

The existing data shows that the most commonly encountered non-native plant is the common dandelion, followed by the common plantain. There are also several species that were only encountered once. Table 9 displays non-native species documented from past inventories from most common to least common.

Table 9. Non-Native Plant records in the Salmon Creek Landscape Assessment Area

Scientific Name	Common Name	Count
Taraxacum officinale F.H. Wigg. ssp. officinale	common dandelion	114
Plantago major L.	common plantain	109
Trifolium repens L.	white clover	87
Poa annua L.	annual bluegrass	78
Matricaria discoidea DC	pineappleweed	73
Phleum pratense L.	Timothy	58
Leucanthemum vulgare Lam.	ox-eye daisy	47
Trifolium hybridum L.	alsike clover	37
Cerastium fontanum Baumg. ssp. vulgare (Hartm.) Greuter & Burdet	big chickweed	28
Poa pratensis L. ssp. irrigata (Lindm.) H. Lindb. or Poa pratensis L. ssp. pratensis	spreading bluegrass or Kentucky bluegrass	24
Rumex crispus L.	curled dock	24
Linaria vulgaris P. Mill.	butter and eggs	19
Lupinus polyphyllus Lindl.	large-leaf lupine	16
Ranunculus acris L.	tall buttercup	13
Rumex acetosella L.	sheep sorel	13
Crepis tectorum L.	annual hawksbeard	11
Medicago sativa L. ssp. sativa	alfalfa	11
Leontodon autumnalis L.	fall dandelion	10
Ranunculus repens L.	creeping buttercup	7
Melilotus officinalis (L.) Lam.	yellow sweet clover	6
Stellaria media (L.) Vill.	common chickweed	6
Hieracium aurantiacum L.	orange hawkweed	5
Trifolium pratense L.	red clover	5
Dactylis glomerata L.	orchard grass	4
Vicia cracca L.	bird vetch, dog pea	4
Alopecurus pratensis L.	meadow foxtail	3
Lolium perenne L. ssp. multiflorum (Lam.) Husnot	Italian rye grass	3
Medicago lupulina L.	black medic, hop clover	3
Melilotus alba Medikus	white sweet clover	3
Bromus inermis Leyss.	smooth brome	2
Chenopodium album L.	lamb's quarters	2
Medicago sativa L. ssp. falcata (L.) Arcang.	yellow alfalfa	2
Polygonum aviculare L.	knotweed	2
Capsella bursa-pastoris (L.) Medik.	shepherd's purse	1
Elymus repens (L.) Gould	quackgrass	1
Galeopsis bifida Boenn.	splitlip hemp-nettle	1
Hesperis matronalis L.	dame's rocket	1

Scientific Name	Common Name	Count
Hordeum jubatum L.	foxtail barley	1
Papaver nudicaule L.	Iceland poppy	1
Phalaris arundinacea L.	Reed Canary Grass	1
Sorbus aucuparia L.	European mountain ash	1
Spergula arvensis L.	spurry	1
Spergularia rubra (L.) J.& K. Presl	purple sand spurry	1
Symphytum officinale	common comfrey	1
Tanacetum vulgare L.	common tansy	1
Triticum aestivum L.	wheat	1
Veronica serpyllifolia L. ssp. serpyllifolia	thyme-leaf speedwell	1

Detailed survey and control work were also conducted by the Resurrection Bay Conservation Alliance (RBCA) in 2008-2010, covering portions of the Seward Highway, Exit Glacier Road, and the City of Seward. Numerous non-native plant populations were found in treated by the RBCA and other volunteers. Populations include *Leontodon autumnalis* along portions of the Exit Glacier Road; *Hieracium aurantiacum, Leucanthum vulgare, Linaria vulgaris,* and *Ranunculus repens* were all located on private property off of Exit Glacier Road; *Melilotus officinalis* was located along the Seward highway and in numerous places in the City of Seward including the Alaska Sea Life Center; *Tripleurospermum perforata*, *Linaria vulgaris, Rumex acetosella, Leucanthemum vulgare, Crepis tectorum,* and *Vicia cracca* are found throughout the City of Seward.

Sensitive and Rare Plants

Sensitive plants, like other plants, are influenced by various biological, chemical, and physical environmental gradients or regimes. A habitat diversity/ bioenvironmental model combining bioclimatic, landcover, and landtype GIS databse layers into a single GIS layer was developed to identify and model various bioenvironmental regimes for sensitive plants (DeVelice et al. 1999). This bioenvironmental database was used to create maps of the potential distribution of all rare and sensitive vascular plants known or suspected to occur on the Chugach National Forest. However, the sensitive species list was revised in 2009 and new maps should be created to reflect the latest sensitive species list. There are six species on the Region 10 Sensitive Plant list potentially occurring in the Resurrection River Landscape Area. These include *Aphragmus eschscholtzianus, Cochlearia sessifolia, Cypripedium guttatum, Ligusticum calderi, Papaver alboroseum,* and *Romanzoffia unalaschcensis*. None of these species has been found within the landscape assessment area. However, *Papaver alboroseum* and *Cochlearia* sessifolia have been found near the landscape area. *Cochlearia sessifolia* occurs in maritime beaches and has been documented in Resurrection Bay, west of the landscape area. *Papaver alboroseum* has been found in an alpine area in the Kenai Fiords National Park.

Fire and Fuels

The analysis area experiences heavy human use year round and is particularly busy during the summer months. Outside the Seward city limits, much of the valley bottom is privately owned and has been subdivided into private parcels supporting many single family residences. The Analysis Area also includes about 12 miles of Highway 9, the main travel route from Seward to Anchorage and approximately 12 miles of railroad track operated by the Alaska Railroad. . Both routes support heavy freight activity arriving

from the Port of Seward headed north as well as coal from Central Alaska headed south to port for export. During the summer, Seward is one of the few sea port communities that can be driven to, and experiences heavy tourist traffic from all forms of vehicles. The east side of the Analysis Area includes several additional residences along Nash Road as well as the Seward Marine Dry-dock and shipyard and the Spring Creek Correctional Facility, a maximum security prison run by the state of Alaska. Additional activity in the Analysis Area includes dispersed camping along the Exit Glacier road on lands managed by the State of Alaska. This dispersed camping is of major concern from a fire management point of view as there can be in excess of 1000+ people camped on both sides of the road over the Fourth of July holiday weekend. Due to this influx of visitors the Chugach National Forest currently has a forest order in place to prohibit any form of open fire source on agency lands along the Exit Glacier road. The heavy human use year round increases fire risk around residences and along travel corridors.

The Salmon Creek Analysis Area has not experienced impacts from the Spruce Bark Beetle infestation on the Kenai Peninsula that started in the early to mid-1990's and proceeded through at least 2007. Estimates of total acreage affected by the latest infestation run as high as 1.4 million acres. It is unknown why the analysis area has not been impacted. One theory is that it may be tied to impacts of human settlement on the Salmon Creek drainage. As Seward was settled and the railroad was built, much of the mature timber that may have been susceptible to beetle impacts would have been harvested for milled lumber, fuel wood, and railroad ties. Data is limited to classify the area by Fire Regime Condition Class and Fire Return Interval. No records exist of a large fire incident in the drainage since settlement. There have been spruce stands impacted by beetles within twenty miles to the west but this infestation has been mostly confined to the upper reaches of the Resurrection River drainage several miles upstream from the Exit Glacier Bridge

At present, condition class mapping of the watershed is unavailable.

Aquatic Species and Habitats

The status of the aquatic species within the assessment area is unknown. In the past the ADF&G personnel have conducted sporadic surveys in Salmon, Bear, Grouse, and Clear creeks to count numbers of spawning salmon in index stream reaches. However, these data are not currently available. Information on the other species is lacking. Catch data from 1996 to 2010 developed by ADF&G do exist for sport fisheries that occur in Resurrection Bay. Such data may be of some use in gauging the relative trend and abundance anadromous species that utilize the assessment area. To use these data in such a manner, the critical assumption is that the number and kind of fish caught in the Resurrection Bay fishery is representative of the species that originate from the Salmon Creek LA area. Obviously this assumption is invalid if a large number of the fish caught in Resurrection Bay are produced in other areas. In addition, the vulnerability of any species to fishing over time may not directly correlate with its actual abundance. Angling regulations may impact catch rates as well as changes that occur in the fishery in terms of which species is most strongly targeted. Therefore, conclusions and interpretations drawn from this information about the state of salmon and char produced from the Salmon Creek LA area should be drawn with caution.

With that caveat, the fishery data show some interesting patterns in species abundance and fishery use. As presented in Table 8, the primary species caught in this fishery was coho with 1996-2010 average of 73,173 fish. This is a large catch for this species and probably represents the largest sport coho fishery in Alaska. In recent years a portion of this catch has been of hatchery origin. From 400,000 to 500,000 coho smolts are released into Resurrection Bay by the ADF&G and Cook Inlet Aquaculture Association. From 2003 to 2005 ADF&G conducted a study and found that about 1/3 of the coho caught in Resurrection Bay came from this hatchery program. However, hatchery coho originating from other release locations in Prince William Sound and Cook Inlet were also recovered.

Substantial numbers of hatchery Chinook and sockeye are also released into Resurrection Bay and tributary waters (Table 10)... Approximately 200,000 hatchery Chinook are released annually with the goal of enhancing the sport fishery. The sockeye program consists of 2,000,000 hatchery fish released into the bay mainly to enhance a commercial fishery that occurs earlier in the season.

The presence of a large number of hatchery fish in this area make it more complicated to determine if current habitat conditions are sustaining wild populations and whether there has been any change from historical times. It is likely that hatchery Chinook, coho and sockeye comprise a majority of the spawners currently utilizing natural salmon production areas in the Salmon Creek LA area. This poses a genetic risk to locally adapted wild populations of these species and may have a depressing effect on how efficient the available fish habitat is being utilized. In addition, the ecological interactions between hatchery fish and other species are poorly understood, but may represent an additional risk factor to the normative production of wild fish within the assessment area.

Table 10. Annual angler use, catch and trend statistics for Resurrection Bay sport fishery by species from 1996 to 2010.

Year	Anglers	Chinook	Coho	Sockeye	Pink	Chum	Dolly Varden	Steelhead
1996	45,687	6,122	74,084	741	4,809	1,676	632	0
1997	49,270	6,436	85,379	1,786	1,528	709	305	0
1998	42,483	3,267	66,979	1,253	2,742	209	861	16
1999	37,910	2,462	71,957	1,020	4,507	647	210	0
2000	37,674	2,600	68,347	1,432	3,847	1,179	228	0
2001	37,733	2,098	82,234	1,011	3,355	540	344	79
2002	36,283	2,752	81,335	1,867	3,478	324	813	298
2003	38,778	2,322	70,797	1,547	3,408	221	204	91
2004	42,958	2,325	85,775	2,300	4,729	963	670	40
2005	44,901	2,161	109,559	4,922	5,637	1,178	146	163
2006	41,099	2,643	68,479	4,372	2,954	715	166	0
2007	43,401	2,934	85,301	4,160	5,180	273	220	66
2008	32,380	1,229	50,139	5,277	4,559	1,174	145	6
2009	33,046	1,356	60,270	10,248	3,512	495	67	21
2010	27,047	1,250	36,959	4,448	2,008	188	89	14
Means	**39,377**	**2,797**	**73,173**	**3,092**	**3,750**	**699**	**340**	**53**
Trends[a]	**-25%**	**-79%**	none	**+1637%**	none	none	**-82%**	none

[a] All species catch data were inspected for the possibility of a trend from 1996 to 2010; the "none" entry is noted where no statistically significant trend ($p > 0.05$) was found.

Based upon an analysis of ADF&G catch data for the Resurrection Bay sport fishery, there has been a statistically significant 25% decline in the number of participating anglers from 1996 to 2010 (Table 10). Of the seven anadromous species caught in Resurrection Bay fisheries, significant trends were found for Chinook, sockeye, and Dolly Varden (Table 10). In the case of both the Chinook and Dolly Varden there has been a substantial decline for the 1996 to 2010 time period of -79% and -82%, respectively (Figure 22). In contrast for sockeye the trend has been strongly upward. (Figure 22).

A small number of fish reported by anglers as steelhead were also caught in this fishery nearly every year. The origin of these fish is unknown; however they could have been produced in the assessment area.

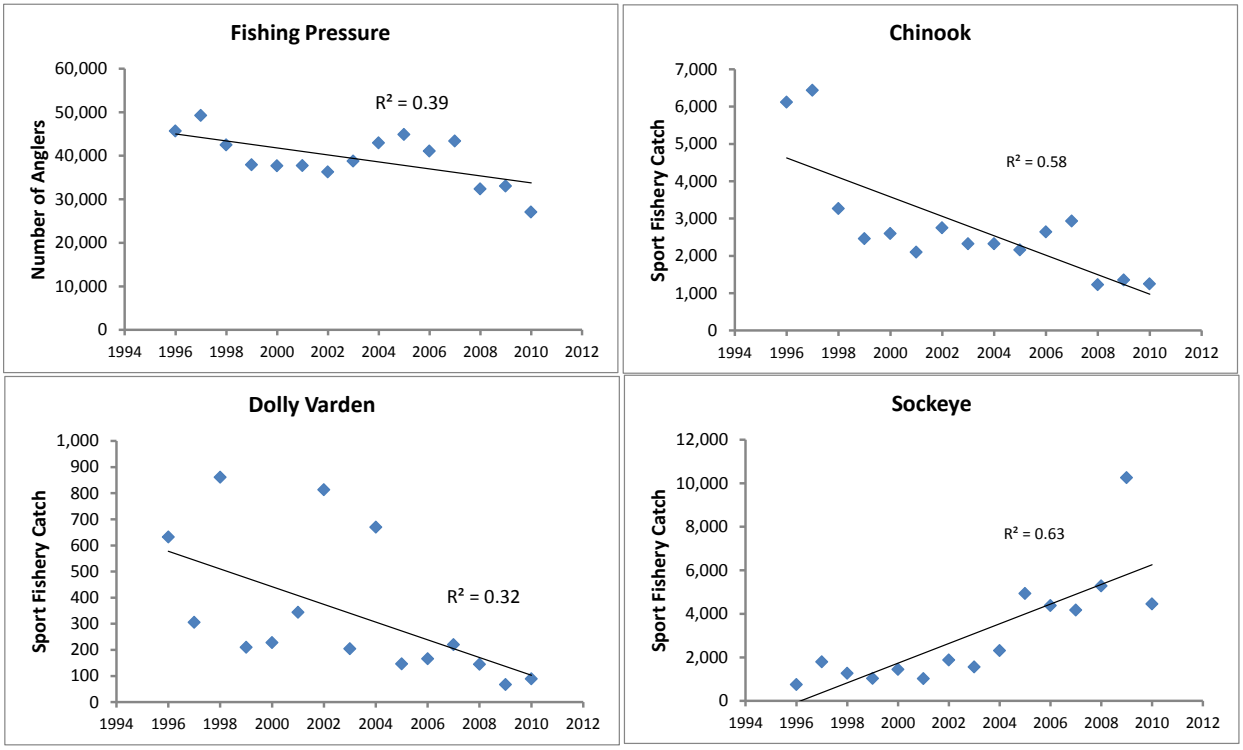


Figure 22. Estimated number of anglers per year and catch of Chinook salmon, Dolly Varden char, and sockeye salmon in the Resurrection Bay sport fishery 1996-2010.

Terrestrial Species and Habitats

Current conditions came from USFS GIS and wildlife survey data, and ADFG data.

Table 11 lists the existing and potential habitat for important species within the analysis area, including Threatened, Endangered, or Sensitive Species (TES), Management Indicator Species (MIS), or Species of Special Interest (SSI). Existing habitat notes the species has been documented to occur. Potential habitat provides suitable habitat characteristics, although it is currently not known to be occupied by the species.

Table 11. Existing or Potential Habitat for TES, MIS, and SSI in the Analysis area

Species	MIS	TES	SSI	Existing Habitat	Potential Habitat
Humpback Whale		X		YES	YES
Beluga Whale		X		NO	NO
Steller Sea Lion		X		YES	YES
Steller's Eider		X		NO	NO
Kittlitz's Murrelet		X		NO	NO
Dusky Canada Goose	X	X		NO	NO
Aleutian Tern		X		NO	YES
Black Oystercatcher		X		YES	YES
Brown Bear	X			YES	YES
Moose	X			YES	YES
Mountain Goat	X			YES	YES
Gray Wolf			X	YES	YES
Canada Lynx			X	YES	YES
Marbled Murrelet			X	YES	YES
Northern Goshawk			X	YES	YES
River Otter			X	YES	YES
Sitka Black-tailed Deer			X	Reported Locally	YES
Townsend's Warbler			X	YES	YES
Wolverine			X	UNKNOWN	YES
Bald Eagle			X	YES	YES

Threatened or Endangered Species

There are no threatened or endangered species or habitat for these species in the landscape assessment area.

Sensitive Species

There are no sensitive species or habitat for these species in the landscape assessment area.

Management Indicator Species

Moose

Moose are primarily associated with early to mid-succession habitat and riparian areas (USDA Forest Service, Chugach National Forest, 2002b) and are dependent on early seral vegetation types including young hardwoods (willow, birch, aspen and to a smaller extent, cottonwoods). The availability of winter range is the major limiting factor for moose population size. On the Kenai Peninsula, other limiting factors include predation, hunting, and mortality from vehicular collisions (Lottsfeldt-Frost, 2000). Renecker and Schwartz (1998) found that the distance between feeding and hiding/ thermal cover also can be a limiting factor, especially in areas of large-scale disturbance.

Chugach National Forest GIS data indicate that moose winter range exists on 7758 acres within the analysis area, primarily centered around Bear Lake (See Figure 23). The majority is on state, city or private land and the Seward Highway runs through much of it. Most areas are classified as conifer

(hemlock or spruce), alder, or cottonwood. These areas are likely more important for hiding and resting than for browsing.

Moose are surveyed infrequently by Alaska Department of Fish and Game in the analysis area. Moose count areas do not conform to the analysis area boundaries, so ADFG was unable to give numbers of moose that use the analysis area or specific trends. Generally, moose numbers are down in many areas in Unit 7 and likely are in this area as well.

The area does not appear to provide much high quality browse, nor is it a great area for habitat improvement in the winter range due to the proximity of the highway. The Alaska Department of Fish and Game considers the overall habitat on the Seward Ranger District to be of low quality and capable of supporting only 2 to 5 moose per square mile.

Mountain Goat and Dall Sheep

Mountain goats use cliffs, alpine, sub-alpine and old-growth habitats and are generally found near steep cliffs with slopes greater than 50 degrees. In Southcentral Alaska, winter habitat may be a limiting factor for mountain goat populations. They are also sensitive to low-level aircraft flights over summer alpine kidding habitats and wintering areas (USDA Forest Service, Chugach National Forest, 2002b).

Based on Chugach National Forest GIS data, mountain goat winter range primarily occurs on south-facing alpine slopes, spread throughout the analysis area on approximately 1910 acres (See Figure 24).

ADFG reports a rough range of 200-300 goats that may use the area at different times of the year, mostly in alpine habitat. Goat numbers in the greater area have been stable. Aerial surveys have not reported any sheep in these areas.

Brown Bear

Data on brown bear habitat in the analysis area is limited.

Brown bears have large home range requirements and are generally intolerant of human activities and development. Suring et al (1998) estimated the Kenai Peninsula population at 280 bears, or about 12 bears per 386 square miles. This is an estimate and ongoing work collecting hair samples and analyzing DNA in cooperation with ADFG and USFWS will assist in updating population estimates in the future. Brown bears throughout the peninsula (units 7&15) have shown a positive growth rate over the past 15 years (personal communication with Thomas Mcdonough, Alaska Department of Fish and Game 2010).

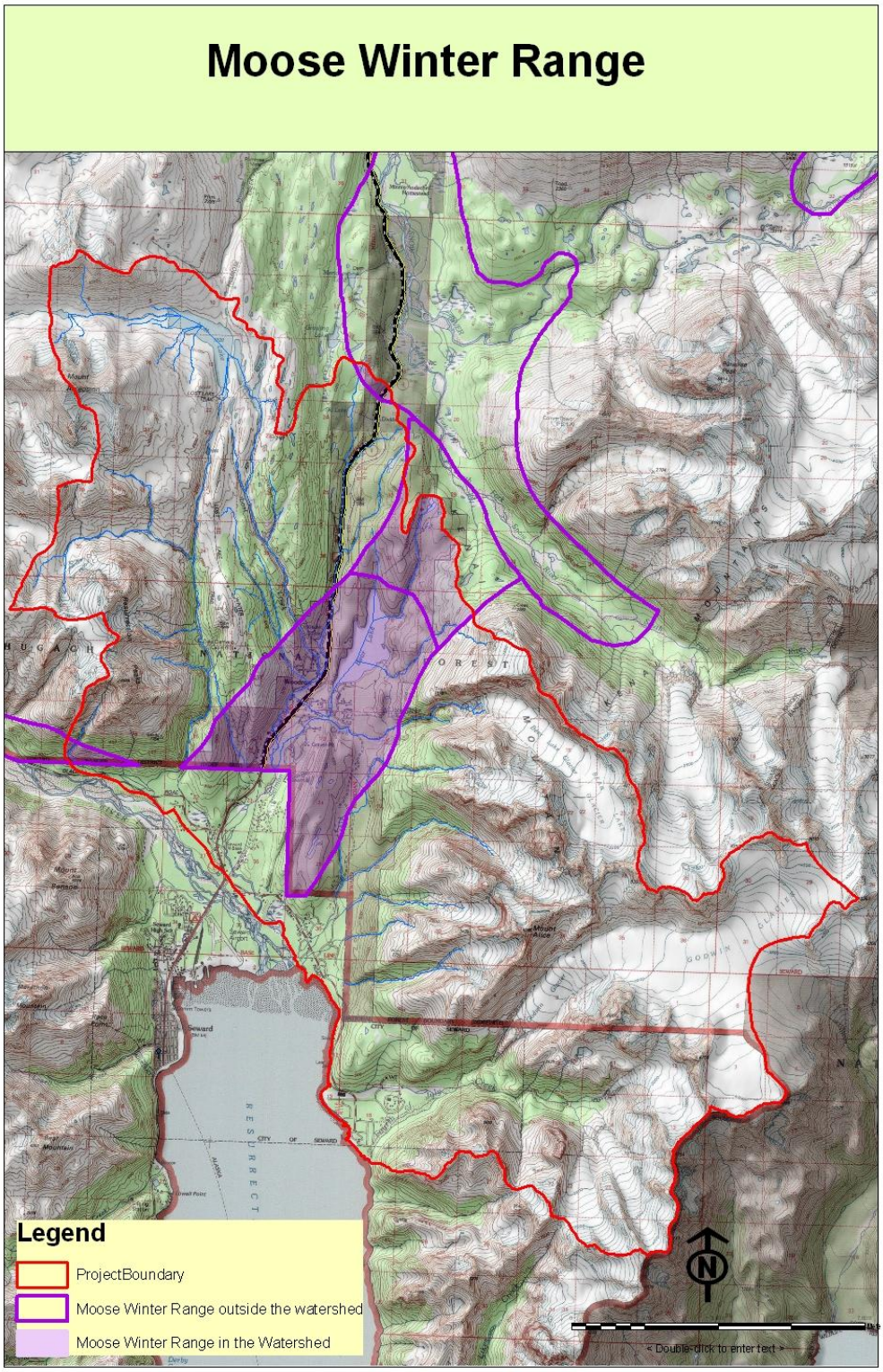


Figure 23. Moose Habitat

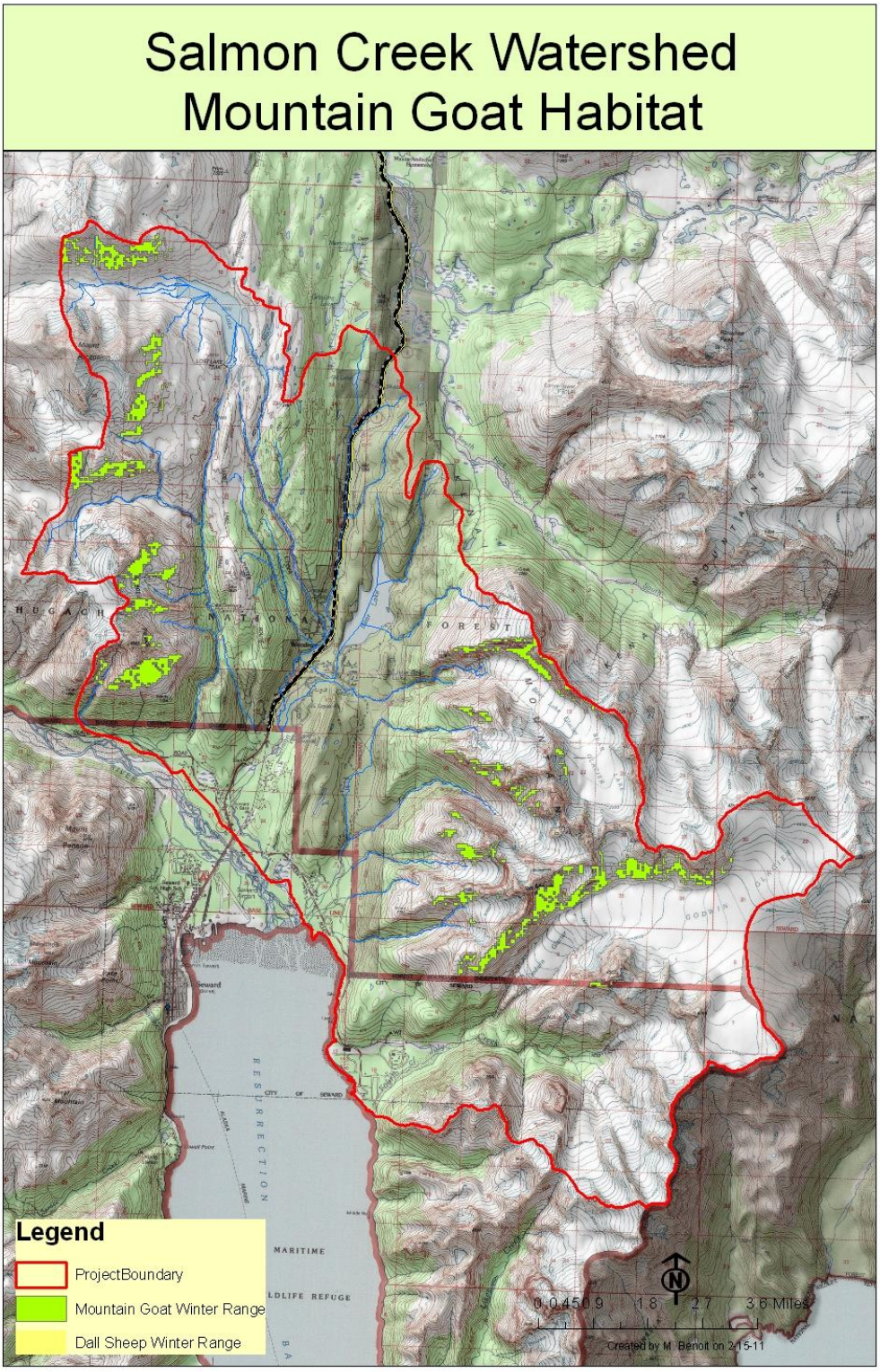


Figure 24. Mountain Goat and Dall sheep Habitat on Forest Service Lands

On the Kenai Peninsula, the primary limiting factor is spring and summer feeding habitat. Spring and summer habitat includes south facing hillsides and avalanche chutes, big game winter ranges, and salmon streams that provide the high quality foods that bears need to develop fat reserves before denning and to replenish fat stores depleted after denning. Carrion, berries, and fish sources in the analysis area provide a diversity of food sources for bears. The analysis area contains numerous south facing slopes, avalanche chutes, winter range for moose, and goats, and salmon in Bear Creek.

Brown bear winter habitat includes potential denning habitat, and post den emergence habitat especially for females with cubs (See Figures 25 and 26).

The best potential denning habitat was identified from a denning habitat model developed by Goldstein et al. (2010-in process of publication). This model predicts the probability of denning across the landscape. Brown bears may den on steep slopes throughout the analysis area. Denning habitat is predicted to exist on 52,643 acres (11,149 acres with 80% probability, 41494 with 100% probability) on steep slopes surrounding Salmon Creek (see Figure 25).

Suring et al. (2006) found when female brown bears with cubs leave dens, they are more associated with upland habitats in close proximity to cover. Suring's brown bear model determines the potential for habitat use in terms of probability. He estimates that the areas with a probability of 80-100% have the highest potential for use. This model predicts one small patch of about 32 acres near Salmon Creek that meeting the criteria (See Figure 25).

In addition, Graves et al. (2007) reviewed GPS collaring data from brown bears collared between 1995 and 2002. The area reviewed did not fall within the analysis area. Adjacent areas contain primary habitat, core areas and travel corridors, indicating bears use areas nearby with similar habitat types and they are known to use this analysis area (see Figure 26).

The effects of recreation on brown bears in the analysis area are currently unknown. Recreation trails (Lost Lake and Iditarod Trails) run through areas which contain high probability of being used by denning bears. These areas are open to motorized use. Trails (Iditarod) and development (private land and the Seward Highway) occur near salmon streams where bears are known to forage (Grouse Creek). The amount of recreation use and the numbers or trends in bear/human interactions are unknown. Flight seeing activities may occur in the analysis area in route from Seward airport or Bear Lake. This activity is generally not managed by Forest Service permits, so the amount and effects on brown bears are unknown.

Roads and trails, other existing development, and increasing levels of recreational activities in the analysis area may reduce the quality of available habitat and increase the number of negative bear-human encounters. On the Kenai Peninsula, habitat modification and human activities have resulted in an increase in the number of brown bears killed in defense of life or property (DLP) (Suring and Del Frate, 2002). During the summer, bears concentrate along low-elevation valley bottoms and coastal salmon streams in areas that are heavily used by people. Salmon congregate in Bear Creek and some of its tributaries (see fisheries section). Encounters may occur at salmon streams, along trails, or near the bear Creek Weir resulting in injury to humans and injury or death to brown bears. ADFG reports an increase in DLP's' around the city of Seward, and 13 DLPs within the analysis area over the last 10 years.

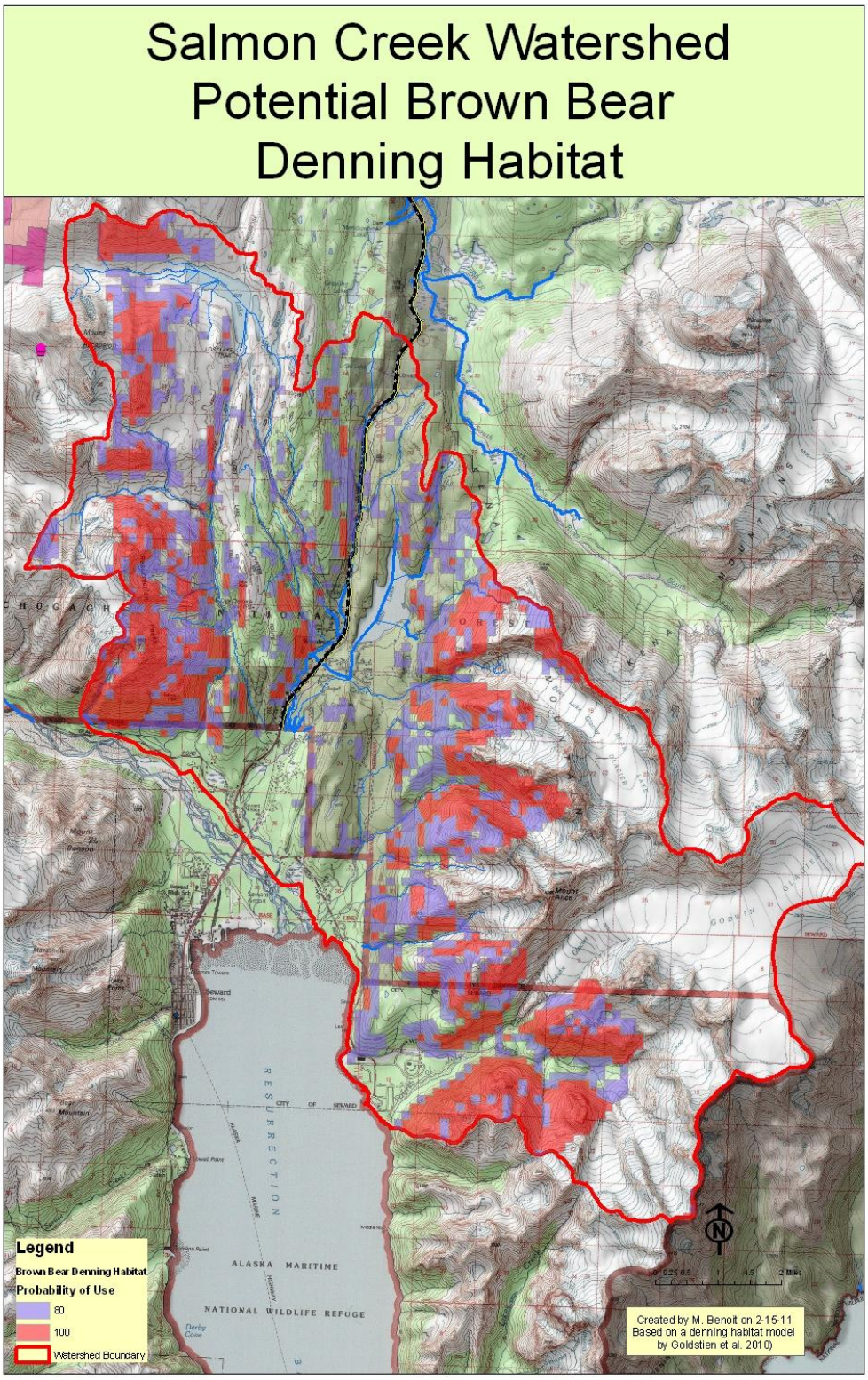


Figure 25. Brown Bear Denning Habitat

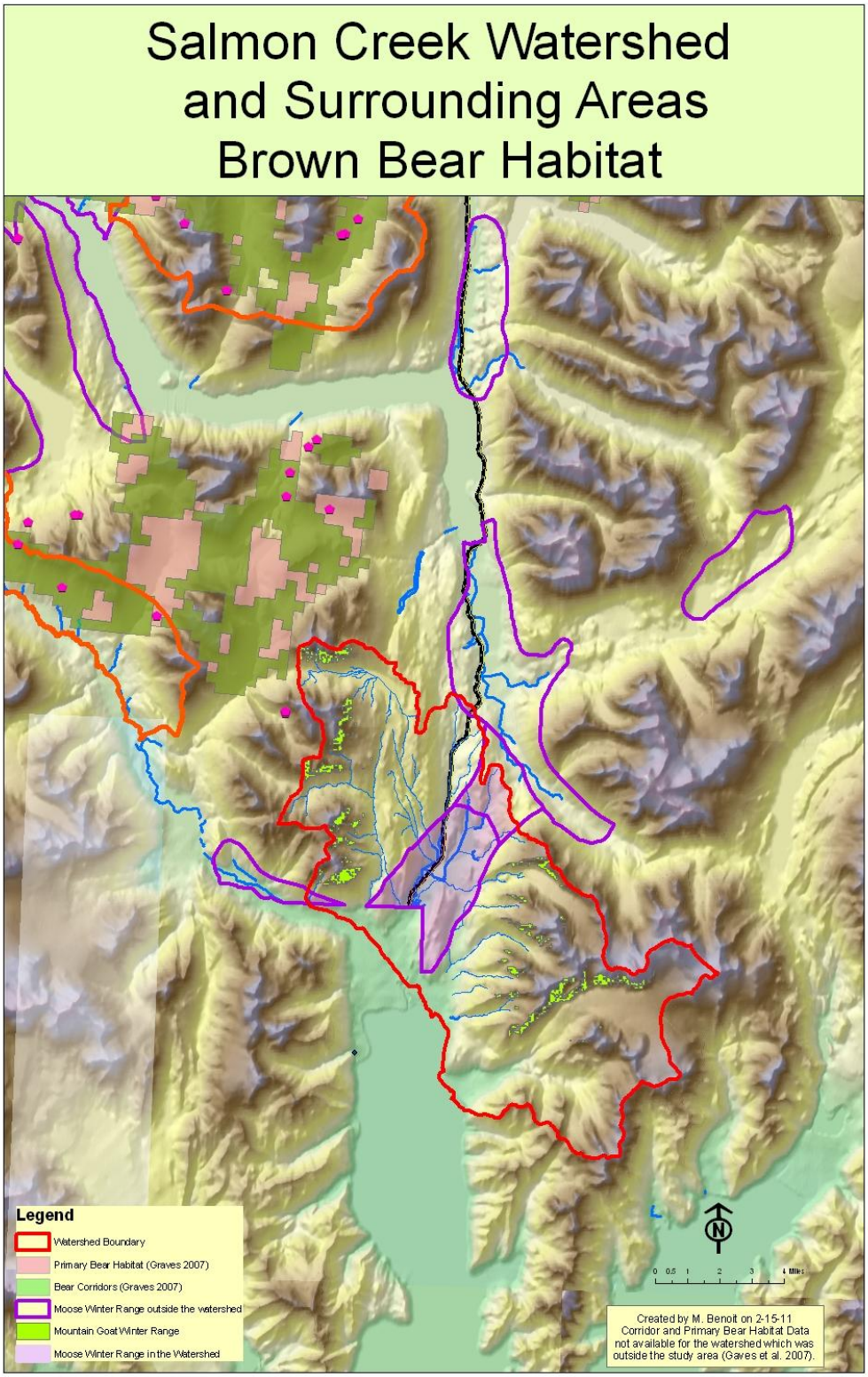


Figure 26. Brown Bear habitat

Species of Special Interest

Bald Eagle

Bald eagles in Southcentral Alaska generally nest in old cottonwood trees near water and use the same nest each year (Daum, 1994). The proximity of large nest trees to food sources is the primary limiting factor for the bald eagle population. Approximately 80 % of all bald eagle nests on the Seward Ranger District are in mature cottonwood trees with an average diameter of 31 inches and within one-quarter mile of an anadromous fish-bearing stream.

There are 14 known bald eagle nests in the analysis area, concentrated along Grouse Creek and Resurrection River and Resurrection Bay near the Seward airport (Figure 27). Most are near developed areas. There are numerous nests within 300 meters of the analysis area boundary. Information on historic populations of bald eagles is not available. Habitat impacts, if they exist in the analysis area, are likely related to natural disturbances such as flooding and human disturbance from recreation and aircraft.

Northern Goshawk

The northern goshawk is an uncommon forest raptor that feeds on small and medium sized mammals and birds (Iverson et al., 1996). They are year-round residents of the Chugach National Forest (USDA Forest Service, 1984). The amount and juxtaposition of feeding and nesting habitat appears to limit population viability in Southeast Alaska (Iverson et al., 1996). The nesting-breeding season is from March to July.

There are no known northern goshawk nests in the analysis area. Surveys have not been conducted to determine if goshawks are present or breeding in the analysis area, but potential nesting and foraging habitat exists (Figure 28). Goshawks have been noted by in Seward and at the Grouse Lake subdivision (personal communication with local residents).

The majority of goshawk nests on the Seward Ranger District are in old growth hemlock-spruce stands characterized by a closed canopy, large average diameter, gap regeneration, and an open understory (Seward Ranger District goshawk nest files). Approximately 80% of nests were in large hemlock or spruce stands with closed canopies. About 15% of nests were in pole sized birch stands and 4% were in large aspen/birch stands.

Stand structural data is old and only available from the forest timber type data which is about 30 years old. Assuming that stands identified as old growth 30 years ago, still are unless they have been cut or disturbed by avalanche, bark beetle, wind throw or flooding, the following map shows potential old growth sites. The areas in green or within conifer stands are the most likely areas for potential goshawk nest sites. Younger stands and more open areas can be used for foraging.

Marbled Murrelet

Marbled murrelets are medium sized seabirds that inhabit near-shore coastal waters, inland freshwater lakes, and nest in inland areas of old-growth conifer forest or on the ground (Carter and Sealy, 1986; Marshall, 1988). Except for the fall period when they are molting, flightless, and stay on the ocean, murrelets are known to fly to tree stands.

Marbled murrelet surveys have not been conducted in the analysis area. Murrelets are known to use Resurrection Bay, and may use mature or old growth conifers in the analysis area for nesting. Residents of Grouse Creek subdivision have reported murrelets using forested areas behind their properties during the breeding season. The majority of the analysis area is within 30 miles of the coast, a distance which murrelets are known to travel inland for nesting. Areas of mature conifer forest are displayed in Figure 29. These areas may contain some potential nest habitat.

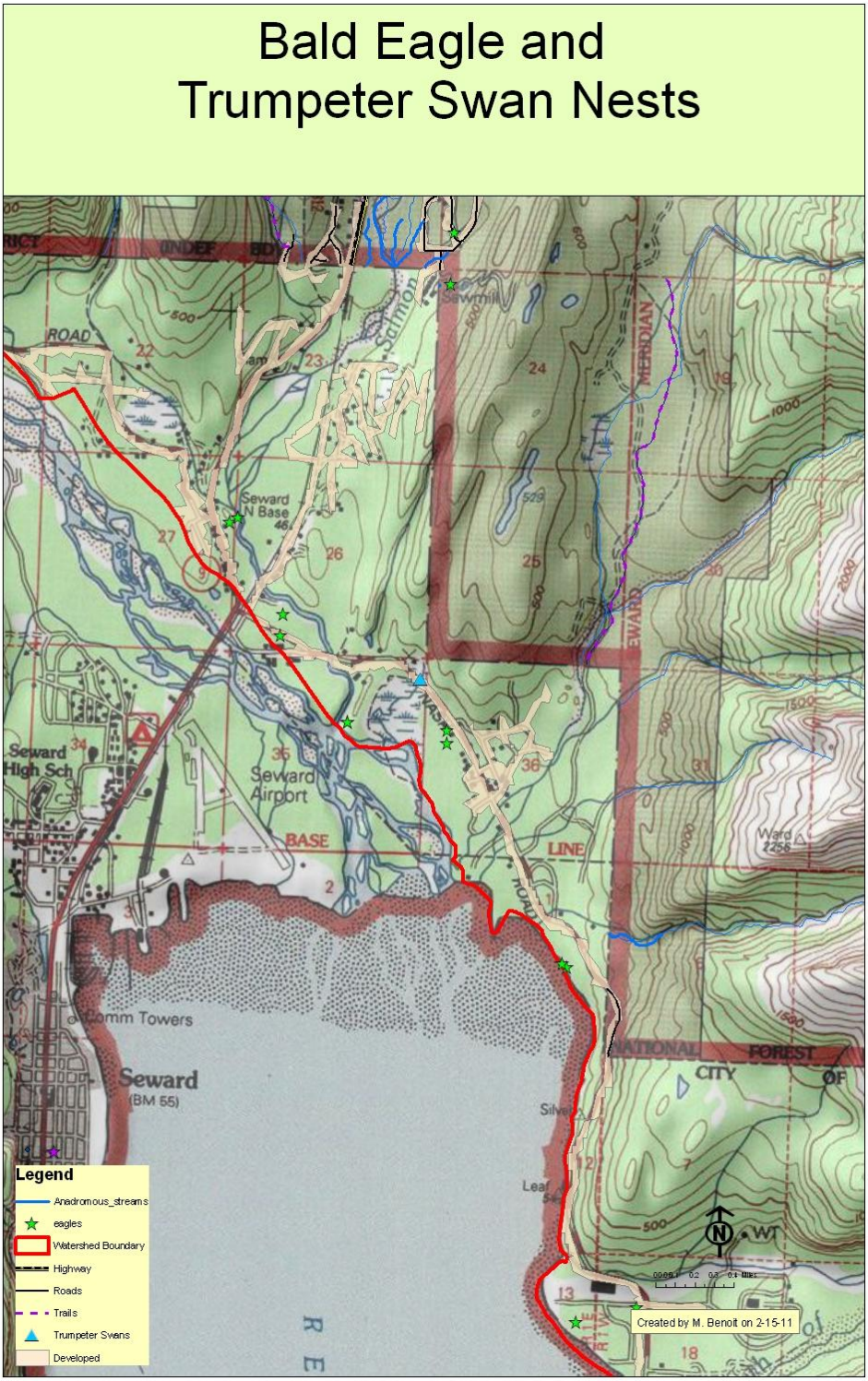


Figure 27. Bald Eagle and Trumpeter Swan Nests

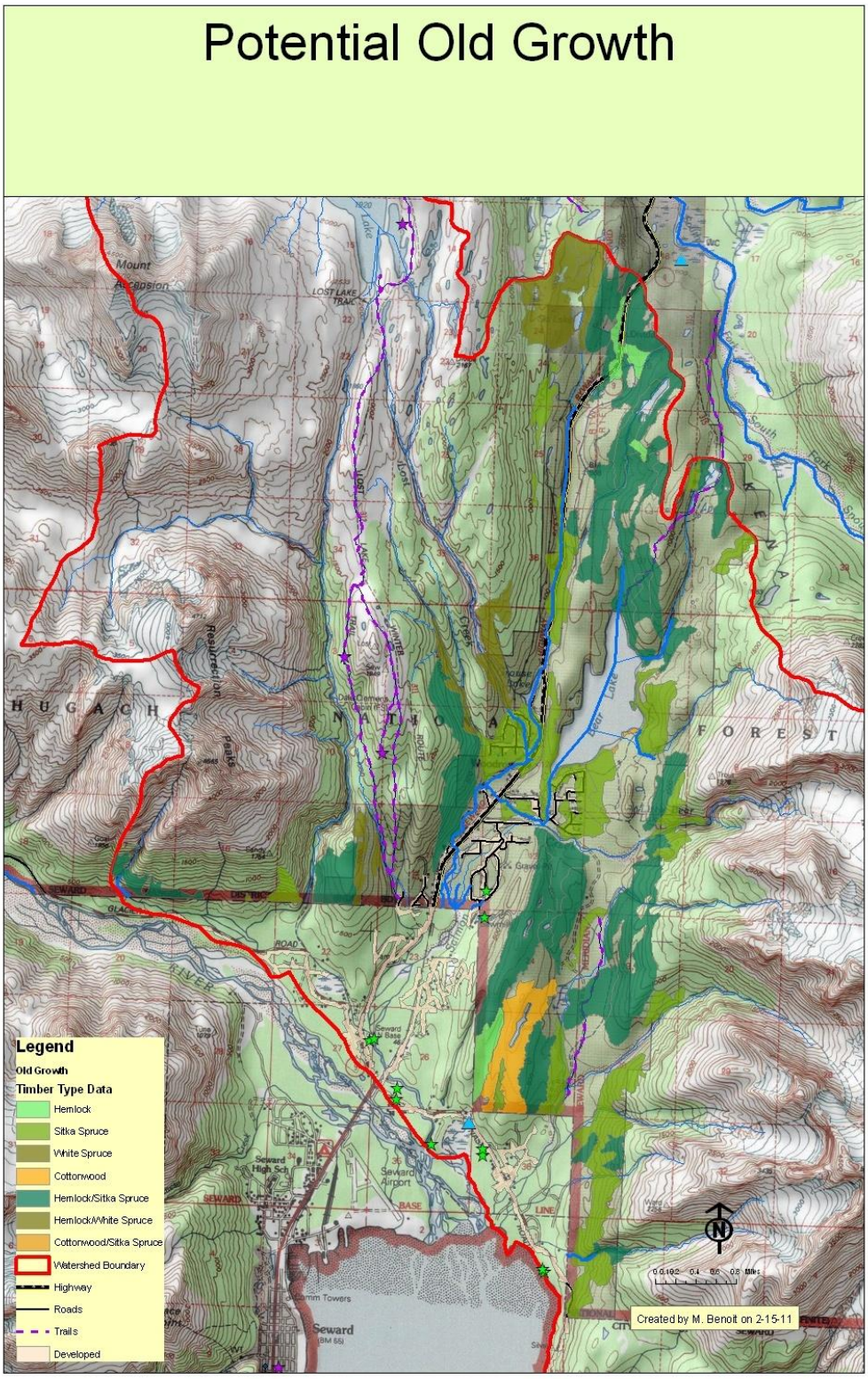


Figure 28. Potential Goshawk nest habitat

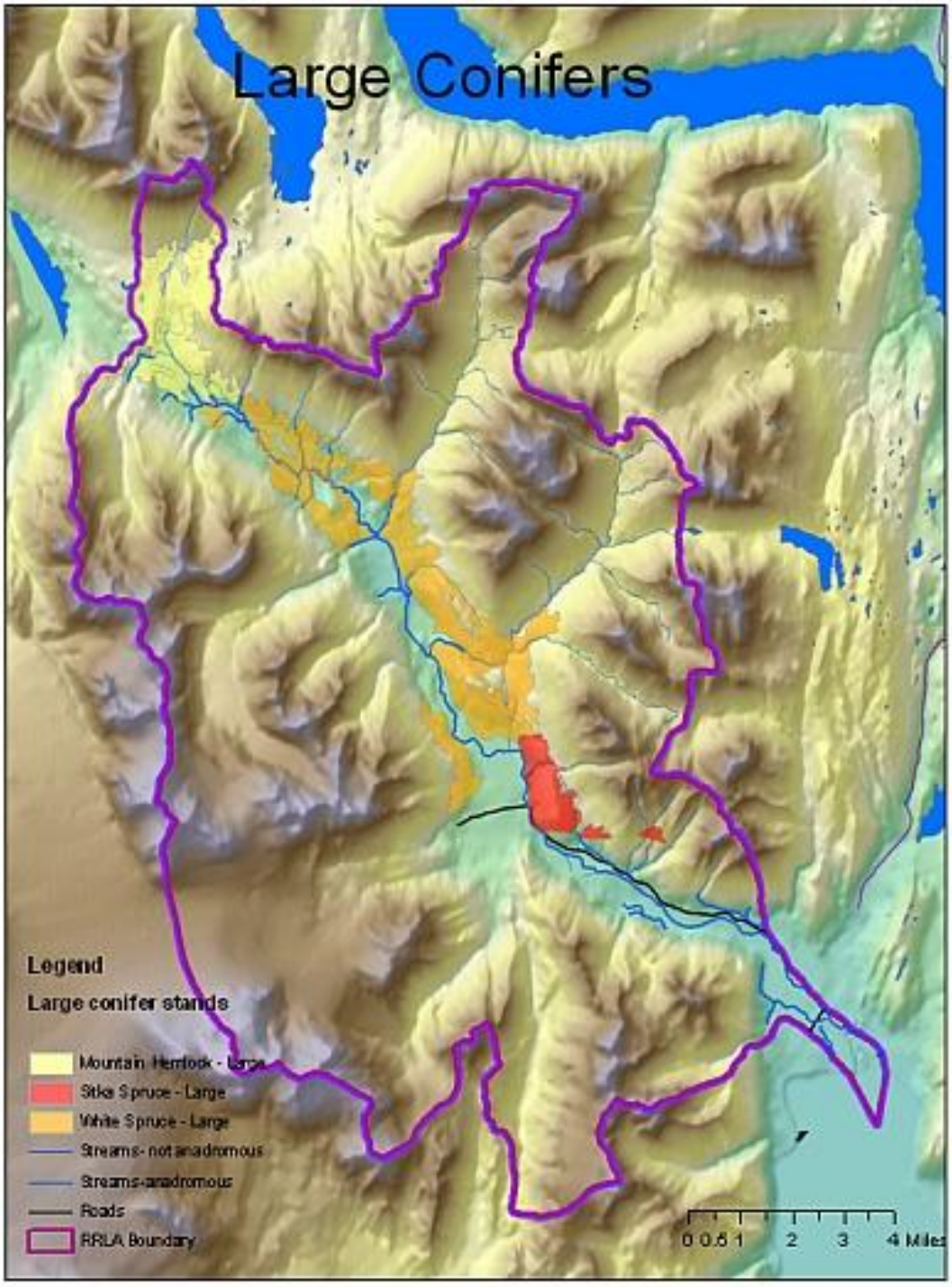


Figure 29. Large conifers

Townsend's Warbler and other Migratory Birds

Townsend's warblers are associated with older, mature spruce and hemlock forests and are not found as often in young coniferous or hardwood forests. Results from surveys on the Seward Ranger District indicate that they have declined in numbers between 1994 and 2000 (Prosser, 2002). Most likely habitat in the analysis area is in mature conifer stands (see Figure 29).

Trumpeter Swans

Trumpeter Swans are known to nest at a pond off Nash Road in Seward (see Figure 30). Unfortunately, several years one of the pair has been killed by vehicles on the road.

River Otter

River otters are associated with coastal and fresh water environments and the immediately adjacent (within 100 to 500 feet) upland habitats (Toweill and Tabor, 1982; USDA Forest Service, Chugach National Forest, 2002b). Beach characteristics affect the availability of food and cover, and adjacent upland vegetation provides cover (USDA Forest Service, Chugach National Forest, 2002b). Otters travel several miles overland between bodies of water and develop well-defined trails that are used year after year (USDA Forest Service, Chugach National Forest, 2002b). River otters breed in late winter or early spring. Young are born from November to May with a peak in March and April (Toweill and Tabor, 1982). The family unit usually travels over an area of only a few square miles (USDA Forest Service, Chugach National Forest, 2002b).

Data on river otter populations in the analysis area are lacking (personal communication with Thomas Mcdonough, Alaska Department of Fish and Game, 2010). Potential habitat may exist in Grouse Creek and Bear Creek and other wetland areas (see Figure 30).

Wolverine

The wolverine is a scavenger and opportunistic forager with a low biotic potential and large home range requirement. Similar to the brown bear, it is sensitive to human activities and development. Recreational uses and hunting may be population-limiting factors.

Little is known about wolverine populations and their use of the analysis area. Wolverines travel over a wide range of habitats in search of food such as big game carrion (moose and goats) that occur within the analysis area. Wolverines are known to use the area (personal communication with Thomas Mcdonough, ADFG, 2011) Foraging habitat exists throughout the analysis area in big game summer and winter ranges (See Figure 31).

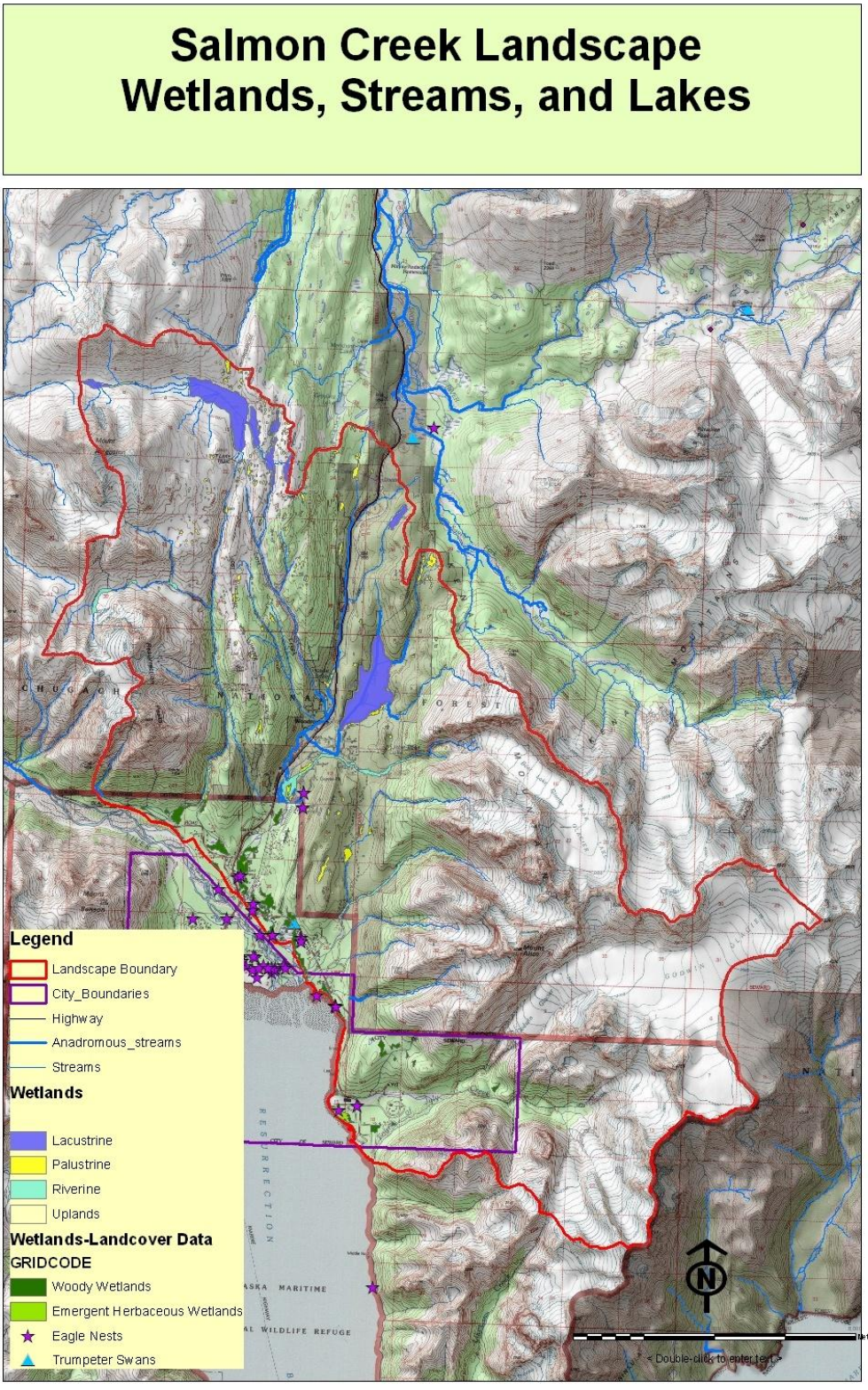


Figure 30. Wetlands and Streams

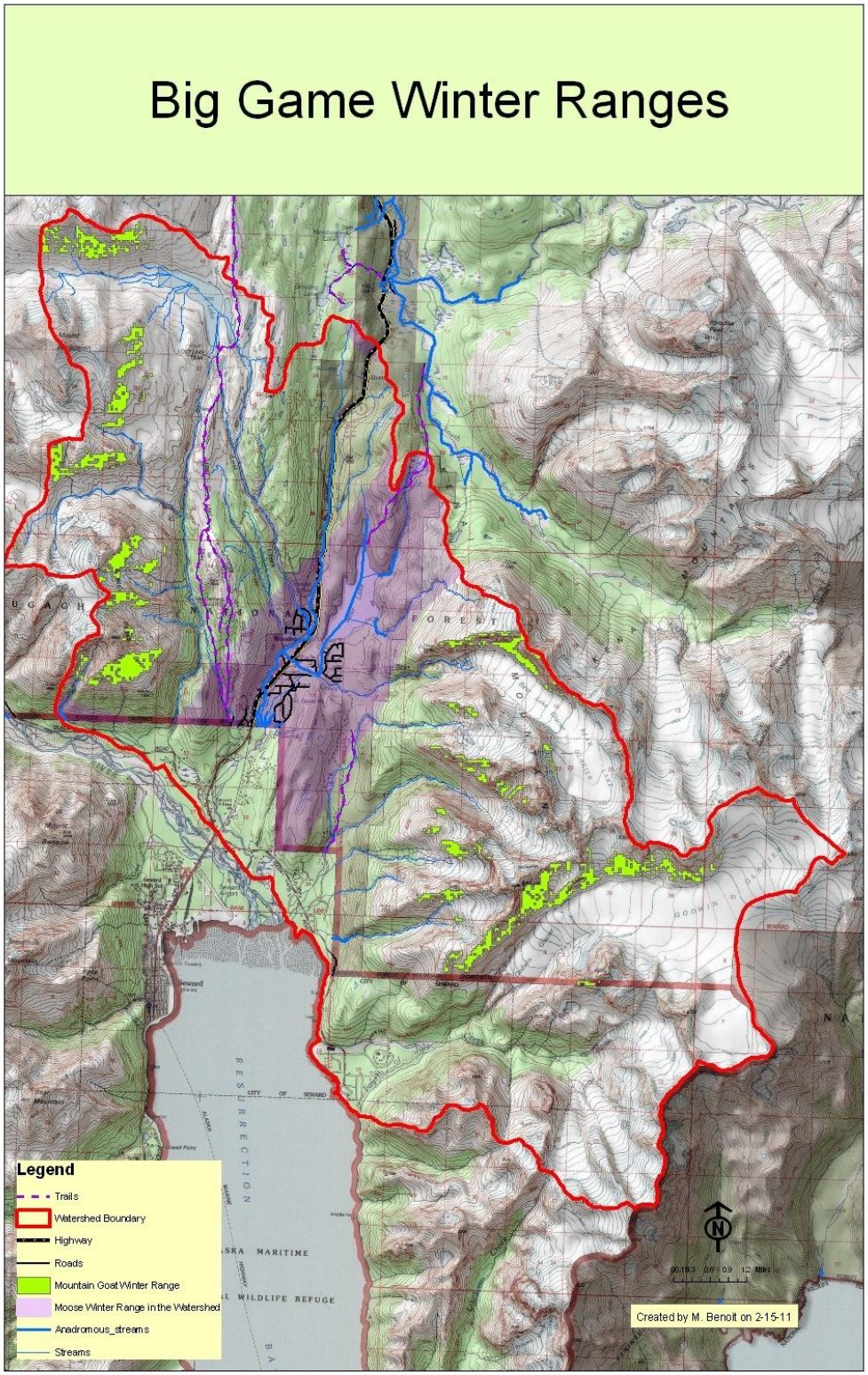


Figure 31. Big Game Ranges.

Lynx

Lynx use a variety of habitats, including spruce and hardwood forests, in early successional communities. They require a mosaic of conditions, including early successional forests for hunting and mature forests for denning (Koehler and Brittell, 1990). Lynx habitat in Alaska occurs where fires or other factors create and maintain a mixture of vegetation types with an abundance of early successional growth (Berrie, 1973; Berrie et al., 1994). In Alaska, lynx tend to use elevations ranging from 1000 to 3500 feet and seldom use unforested alpine slopes (Berrie, 1973). Mating occurs in March and early April, and kittens are born 63 days later under a natural shelter such as a wind-fallen spruce or rock ledge (Berrie et al., 1994). Cyclic changes in snowshoe hare and other small mammal populations (Poole, 1994) influence the production and survival of lynx kittens dramatically. The populations of lynx on the Chugach National Forest are thought to be stable and within the range of historic viability (USDA Forest Service, Chugach National Forest, 2002b). Lynx probably occur throughout forested sections of the analysis area, but no data are available.

Gray Wolf

Wolves are habitat generalists. During winter, wolves are found at lower elevations in forested or woodland areas (Stephenson, 1994). Wolves are highly social animals and usually live in packs that include parents and pups of the year. Pack size usually ranges from two to 12 animals. In Alaska, the territory of a pack often includes from 300 to 1,000 square miles of habitat, with the average being about 600 square miles (Stephenson, 1994). Wolves normally breed in February and March, and pups are born in May or early June (Stephenson, 1994).

I have observed wolves in the analysis area in 1992. It is likely they forage throughout the analysis area in big game summer and winter ranges (See Figure 31).

Sitka Black-Tailed Deer

Seward residents sometimes report seeing deer, and some say a healthy population lives behind the prison in Seward. Alaska Department of Fish and Game reports no documented reports of deer on the Kenai Peninsula (personal communication with Thomas McDonough, 2010). It is unknown if they inhabit the analysis area.

Other Species of Interest

Black Bear

Black bears are common in the analysis area and can be a nuisance in Seward and near private residences where they get into unprotected garbage, pet food and other items with odors that attract bears.

Heritage Resources

Less than 0.1% of the landscape assessment area has been surveyed for the presence or absence of cultural resources. Five historic cultural sites have been identified and inventoried in the course of these surveys. Summary information concerning National Register eligibility for these sites is provided in Table 13. These sites have been reported to the Alaska State Historic Preservation Officer (SHPO), and they have been assigned both Alaska Heritage Resource Survey (AHRS) numbers. A summary of data concerning cultural sites identified within the assessment area is provided in Table 14. Summary of Known Cultural Sites in the Assessment Area since more than 99% of the landscape assessment area remains un-surveyed for cultural resources; the potential exists for further sites.

Kenai Mountains-Turnagain Arm National Heritage Area

On March 30, 2009, the Omnibus Public Lands Management Act of 2009 was signed, designating Alaska's first national heritage area, known as the Kenai Mountains-Turnagain Arm National Heritage Area, which focuses on the theme of transportation for mining and settlement. The Salmon Creek drainage falls within the boundaries of this NHA, and the Forest Service anticipates working closely with the Kenai Mountains-Turnagain Arm Heritage Corridor Communities Association (KTCA) and National Park Service to interpret the historic resources in the area.

Table 12. Cultural Site Types in the Landscape Assessment Area

Site Type	Number of Sites
Historic Sites	5
Prehistoric Sites	0
Multicomponent Sites	0

Table 13. National Register Eligibility of Cultural Sites in the Landscape Assessment Area

Type of National Register Determination	Number of Sites
Cultural Sites Listed on the NRHP	0
Cultural Sites Determined Eligible for the NRHP	1
Cultural Sites Determined Ineligible for the NRHP	0
Cultural Sites Not Evaluated for NRHP Eligibility	4

NRHP: National Register of Historic Places

Table 14. Summary of Known Cultural Sites in the Assessment Area

Site Number	NRHP Status	Site Type
SEW-01191	eligible	Historic
SEW-00012	undetermined	Historic
SEW-01323	undetermined	Historic
SEW-00027	undetermined	Historic
SEW-00114	undetermined	Historic

Style = table note

Recreation

There is approximately 38,170 acres of National Forest System lands within the watershed. Of that 90% of the area is in the backcountry management area prescription as mapped according to the Chugach National Forest Revised Land and Resource Management Plan (USDA 2002a). This management area emphasizes a variety of recreational opportunities for backcountry activities in natural appearing landscapes. The desired condition for this Backcountry Management Area is to provide opportunities for solitude, isolation and quiet when traveling cross-country. The Recreation Opportunity Spectrum (ROS) will range from Primitive to Semi-primitive Motorized. Scenery will be natural in appearance. Recreation Cabins may be present and viewing sites, or interpretive signs may be constructed. Tourism related activities may involve various group sizes with limited facilities. A 2236 acre stripe of land on the west side of the watershed is zoned as Fish, Wildlife and Recreation. This acreage is adjacent to private lands. Fish, Wildlife and Recreation Management Areas provide a variety of habitats for fish and wildlife species and year-round recreational opportunities in both developed and dispersed setting. This

management area provides a wide range of recreation opportunities. Opportunities for solitude and quiet may be limited due to frequent contact with other users near the road or trail systems. The ROS can range from Semi-primitive Non-motorized to Roaded Natural. Evidence of human use such as trails, hardened campsites and historic structures are evident. Recreation Cabins may be present and new cabins may be constructed. Tourism related activities should accommodate large groups.

Forest Service Easements on non-federal lands

- Iditarod "Recreation" Trail – 100 ft. easement with a 1000 ft. buffer
- Forest Entrance Sign – 1 acre site easement
- Lost Lake Trail – 25 ft. easement
- Lost Creek Winter Access – 25 ft. easement
- South Fork Trail – 25 ft. easement
- Bear Lake Access – 60 ft. easement

Recreation

In comparison with other areas on the Seward Ranger District, there are few recreation facilities on National Forest System lands within this watershed. However, there is high use due to the close proximity of Seward. Most of the recreation use on National Forest System lands is concentrated within the Lost Lake area and along the established routes to that area. The Iditarod Trail is seeing increasing use but it is not well known outside of the local area. The existing recreation facilities in the Resurrection Watershed are presented in the following Table 15

Table 15. National Forest Recreation Facilities & Trails located in the Salmon Creek Watershed

Recreation Trails		Length/Location
Lost Lake Trail	High Use Summer & Winter Trail	7.33 miles
Dale Clemens Cabin	Moderately High Use Cabin	N60 11' 29,945"/ W 149 25' 1.552" W
Lost Lake Trailhead	High Use Summer & Winter Facility	N60 11.7' 0", W149 35.2' 0
Iditarod Trail	Moderate to High use Trail	12.5 miles
Primrose Trail	Last mile of this 7.5 mile moderate trail in watershed	1 mile

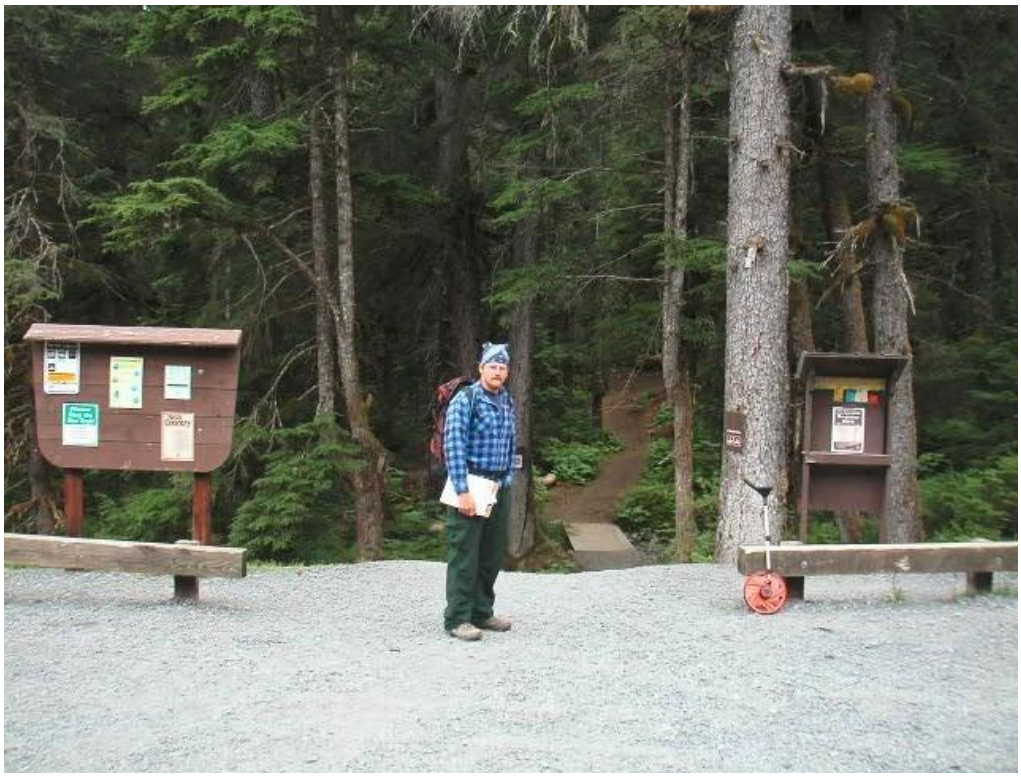


Figure 32. Lost Lake Trailhead

Trail Descriptions

There are three major Forest Service System trails in the Salmon Creek Watershed. Table 16 contains available recreation use data for the major trails monitored by the Forest Service within the within the watershed.

Lost Lake Trail: This 7.33-mile trail begins in the Lost Lake subdivision at mile 5 of the Seward Highway. The ending point is at the bridge over Lost Creek, just below the outlet of the lake. The trail is a very popular year round trail. The winter trail is located in a different location from the summer trail. Trail improvements accomplished during the 1960's greatly increased access to Lost Lake area. In 1994 the Forest Service secured property within the Lost Lake subdivision to locate the permanent trailhead off of private land. The first access was developed by the city of Seward exploring possibilities of using Lost Creek for hydropower. There still are remnants of old wood tripods at the lake below Lost Lake, from the air one can see the route traveled by dozer and 4 wheel vehicles still etched in the fragile alpine areas. The trail offers an easy route into a spectacular alpine area.

Iditarod Trail: Nash Road to the top of Divide, approximately 12 miles. The first section of this trail traverses on a series of old logging roads from Nash Road north through the Sawmill Creek Drainage, crossing Glacier Creek, and continuing around Little Bear Lake, north to Bear Lake. ATVs and snowmachines are allowed on this segment of trail. From the south east side of Bear Lake the trail narrows down and runs along the east side of Bear Lake. This section of trail is necked down and ATVs are not allowed on it. Snowmachines use the frozen lake during the winter on this section. From the north end of Bear Lake to the Divide the trail is an old skid trail built by the CCCs. This series of trails are being developed as an alternate route for the historic trail that was located where the Railroad and highway exist today. Trailheads have not been developed at the accesses.

Primrose Trail: Only the last mile of this 7.5 mile trail is within the watershed. The Primrose trail was a miner developed trail tied in with the Primrose Miner and some prospects around Lost Lake. This trail makes a 14 mile tie through with the Lost Lake Trail that is used by Mountain Bikers, Day Hikers and Overnight Users. Access to the trail is from Primrose Campground at the end of the Primrose Spur Road, Mile Post 17 of the Seward Highway.

Clemens Cabin Access Trail: This trail is the primary summer trail from the Lost Lake Trail to the cabin. It starts at Mile Post 3.8 of the Lost Lake Trail and traverses back south through the sub-alpine to the cabin. It is 1.44 miles long. The winter route overlays segments of this trail.

Goat Hunting/User Developed Trails: There are four known user developed trails within the watershed. These are little known routes used primarily by a few locals. The first one is an old goat hunting trail off the Iditarod up Tiehack Mountain (Tiehack Trail). Another popular user developed trail is the Mount Alice Trail. This route starts at approximately Mile 3.5 of Nash Road. It crosses through State land before entering National Forest. From the alpine area of Mount Alice the views look back west across the bay towards Seward. The South Fork Trail is an old tiehack trail that starts off of the Iditarod near the southeastern corner of Bear Lake and travels up over the Divide near the base of Tiehack Mountain to Boulder Lake. The Lost Creek Trail is an old miner access trail that starts off the power line near Grouse Lake. It traverses along the north side of Lost Creek to tree line and an old mine site below Lost Lake.

Table 16. Trail Register Count Totals,

Trail	Year	2005	2006	2007	2008	2009	2010
Lost Lake	**People**	5560	4715	5047	6315	5353	6629
Iditarod	**People**	No use Figures	No use Figures	No use Figures	No use Figures	No use Figures	No use Figures
Primrose	**People**	2558	3794	2815	4685	5099	4966

Through observations recreation staff estimates that on an average about 38 percent of the summer visitors using the Lost Lake Trail actually register. 19% of the summer visitors register at the Primrose Trail. Typically, horseback riders, bicyclists and snowmachiners do not register at Forest Service trailheads. Use numbers are adjusted accordingly from the trail register.

As indicated in the table between 4500 and 7000 visitors travel up into the alpine area of the upper watershed. The use data for this trailhead supports the assertion that recreation use is high in the upper watershed. High use areas on the Seward District have over 1,500 users registering (4550 visitors) annually at trailheads. Use levels have been increasing gradually over the last 5 year period. There is no data on how many of these visitors are day users or overnight travelers. There is no user data for other routes within the watershed area.

Public Use Cabins

The Salmon Creek Watershed contains only one Forest Service public use cabin. This cabin was built by volunteers from Seward in 1990. It was named after a former High School Coach, Dale Clemens. Its

occupancy rate in 2010 was 48.5%. It sleeps 4 comfortably. It is used in both the summer and winter season and use has been increasing slowly.

Forest Service Recreation Sites: The Lost Lake Trailhead was built in 2000. Prior 2000 the trail access was through private land. This trailhead was built on lands acquired through a land swap within the Lost Lake Subdivision. The trailhead accommodates approximately 14 vehicles with snow machine trailers and 10 cars. The Forest Service maintains the access road year round to keep vehicle congestion down within the subdivision.

Figure 33. Dale Clemens Cabin

Special Use Authorizations

Outfitter & Guide Commercial Use –

There are several Outfitter/Guide permits for the Lost Lake Area. In 2010 there were 476 client days reported on this trail system.

Reference Conditions

This section documents the knowledge of past conditions in the Salmon Creek Analysis area. In order to understand the condition and changes that have taken place, it is important to establish a frame of reference. For this analysis, the time frame for reference conditions varies based on times of important changes for particular resources. For some resource areas, little is known about changes over time, and proxy indicators are sought to help simulate what are thought to be reference conditions. In other cases, there are no good proxies for past conditions, and reference conditions may be based on knowledge of reference conditions of other analysis areas, or knowledge of processes known to have taken place. Generally, reference conditions are those conditions that would be present if the analysis area were operating without significant human influence. It is also important to note that many of the changes in the analysis area since reference conditions are the result of natural geomorphic change.

Lands

The United States obtained title to lands in Alaska by treaty with Russia in 1867.[11] Shortly thereafter, the United States began reserving lands from the public domain for military and other purposes. Among the first reservations for conservation purposes in this new territory was a Forest and Fish Culture Reserve established on Afognak Island by President Benjamin Harrison in 1892. The Chugach National Forest was created through a series of Presidential Proclamations, Executive Orders and Public Land Orders that followed, and was combined by Executive Order with the Afognak Island Forest and Fish Culture Reserve in 1908.

In 1909, President Theodore Roosevelt issued an Executive Order that added several lands to the Chugach National Forest, including significant portions of the Kenai Peninsula. Certain southern portions of the Kenai Peninsula, including portions of the project area, remained excluded from the Forest until a 1915 proclamation again changed the Forest boundary, relocating its southern extent within the Salmon Creek watershed to the area around the Milepost Six of the Alaska Railroad. By 1925, the Forest boundary had again been modified to include most lands within the Salmon Creek Watershed. Most lands around the head of Resurrection Bay, however, fall outside the Forest boundary.

In 1904, at the order of Gifford Pinchot, the first Chief of the Forest Service, W.A. Langille surveyed forested lands in Alaska, including lands of the Kenai Peninsula. Although the human population in Seward was sparse at this time (approximately 200 individuals), the Kenai Peninsula was already experiencing the beginning of "a twenty-year boom period involving land, resources, and railroad building."[12] Consequently, lands within the project area were significantly modified at the time the Chugach National Forest boundary was expanded to include the Salmon Creek watershed.

Geology Minerals and Soil

Geology and Minerals

Reference conditions are not applicable to geology.

Soils

Reference conditions are similar to the current conditions for the Salmon Creek Analysis Area.

[11] Treaty for the Cession of the Russian Possessions in North America to the United States

[12] Rakestraw, Lawrence W. *A History of the Forest Service in Alaska*. 1981 Reprinted by the USDA Forest Service in 1994 (see p. 37).

Hydrology

Reference conditions for water resources are defined as the conditions that existed prior to human development within the area. At this time, no roads or highways existed in the analysis area, and water resources were largely undisturbed by human activities. Information about reference conditions must be inferred, as photography and other information are not available.

Geomorphic Trends

Episodes of extensive glaciation and recession have occurred in south-central Alaska in the past 2 million years, with the last peak of glaciation occurring in the late Pleistocene (20,000 to 25,000 years ago), when glaciers filled each of the main valleys in the analysis area. Rapid melting occurred in the Holocene, beginning about 12,000 years ago, accompanied by numerous episodes of small advances and retreats. The last glacial maxima occurred during the Little Ice Age (approximately 1350 to 1870 AD). At that time, glaciers in the analysis area extended considerably further than they do today, with considerably greater ice thicknesses. By the early 1900s, glaciers in the analysis area began retreating fairly rapidly.

During the reference period, the landscape of the Salmon Creek area was more dynamic than it is today. With increased glacial coverage, sediment loads in streams were higher, leading to active glacial outwash channels with frequently migrating channels where not confined by topography. With sizeable glaciers in most of the tributary watersheds, alluvial fans were likely very active because of high sediment loads. Stream flows may have been higher during the reference period than they are today because of the higher percentage of the watershed covered by glaciers.

Human Impacts to Water Resources

River and stream channels in the Salmon Creek analysis area during reference period functioned primarily under natural processes. Prior to human development in the Seward area, river and stream channels were unimpeded by roads, bridges, levees, or other artificial controls and human impacts to water resources were minimal. The water in most streams was moderately to extremely turbid as a result of numerous glaciers throughout the area.

Impacts of Channel Changes and Flooding

During the reference period, the Seward area was minimally developed. Flooding was likely fairly frequent because of heavy precipitation and the presence of glaciers in the watershed. Outburst floods may have occurred in some of the streams in the area as a result of landslide debris dams. However, channel changes and flooding in the area did not have a large effect on human developments or populations because of the lack of development.

Climate

Prior to the early 1900s, it is likely that the climate was somewhat cooler than it is today. The current trend of climate change that can be attributed to emissions of greenhouse gases was not occurring during reference conditions. However, the global climate was in a state of warming after the Little Ice Age.

Vegetation and Ecology

Not much real data is readily available on reference conditions for vegetation; assuming reference vegetation conditions are those predating European settlement. Langille's (1904) "The Proposed Forest Reserve on the Kenai Peninsula Alaska" describes the conditions around the early 1900s. Langille's description portrays the entire Kenai Peninsula and provides some information about past anthropogenic disturbances. The disturbances described in this publication are logging and human-caused fires.

Regarding natural disturbances, Langille says, "Along the bayshore 40 to 60 percent of the older standing trees are dead, and on the high plateau 80 to 100 percent are dead but still standing, having evidently all died about the same time." (Langille 1904). Presumably these dead trees are the result of a spruce bark beetle (Dendroctonus rufipennis) outbreak. The scale at which this disturbance occurred is unknown.

The Earth's climate is constantly changing in ways that scientists are not able to reliably predict. Also, "plant interactions observed at any time are unique to the climate as well as the species" (Oliver and Larson 1996). Since plants move on a landscape independent of one another in response to climatic shifts (Oliver and Larson 1996), it is impossible to predict what changes may occur in plant communities as climate changes occur. However, it is reasonable to conclude that the forested landscape will increase by moving higher in elevation with warmer temperatures. The best way to respond to potential changes in the future is to manage for the maintenance of diversity of plant species.

Botany and Weeds

Non-native Plants

Prior to significant human settlement in the 1800's, there were likely no non-native plant species in the project area. Non-native plants become introduced in a variety of ways, mostly associated with human activities such as intentional planting in gardens or for re-vegetation purposes, and accidental introductions via seeds and plant materials transported via vehicles or livestock.

Sensitive and Rare Plants

There is no reference condition data for sensitive and rare plants. Historically, the *Papaver alboroseum* may have been more common as receding glaciers revealed potential habitat. However, as these sites continue to grow in with vegetation, habitat for the *P. alboroseum* may diminish.

Fire and Fuels

The evidence for prehistoric fire events on the forest from radiocarbon dates on soil charcoal range from 4500 years before present (ybp) to 570 ybp (Reiger 1995). Historical evidence supporting a climax forest is cited by the following authors. (Langille 1924 and Holbrook 1924). Both concluded from evidence indicated by old logs and decayed stumps of large size, that a prehistoric forest of greater proportions once existed, probably destroyed by fire before the Russian occupancy of the region. Although large historic fires were recorded on the Forest during the settlement period, we do not know how this compares with the number and size of fires during prehistoric fire history.

Beginning in the late 19th century and continuing through the early 20th century, this period shows high fire frequencies on the west side Kenai Peninsula. Perhaps the earliest written occurrence of Russian occupancy on the Forest was in late 1793 (Pierce, 1980). Russian shipbuilders prospected in the Kenai Peninsula Mountains for iron ore. The iron ore was transported down along Resurrection to the bay.

The coming of the American gold seekers saw the first use of the forests, exploiting the forests to obtain lumber for sluice boxes (Langille, 1904). Many of the gold seekers were careless with fire, with the result that they burned not only a large part of the timber but their cabins and outfits as well (Holbrook 1924).

Commentaries from the foresters diaries early in this century, describe extensive fires on the Forest between 1913- 1915. The basic cause for these fires was attributed to railroad activity igniting 95 fires between 1932 and 1953. (Chugach fire history data) The drought conditions following the 1912 Katmai Volcano eruption also contributed to the fire behavior creating favorable weather for burning. Holbrook 1924) also reports "the region has been visited by numerous fires and most of the better grade of timber has been burned". He mapped approximately 30,000 acres of burned area on the forest. These large disastrous fires included the Resurrection Creek watershed covering 10,000 acres including the Hope fires; namely Cripple Creek, Bear Creek and Sunrise fires (1904-1930) burning a total of at least 6,000 acres. None of the large fire activity documented in these reports has taken place in the Salmon Creek Analysis area.

Human impact on the forest has varied and early impacts have been masked by those which came later. Existing fire report data documents numerous responses to fire starts in the Analysis Area. The total number of ignitions that may have taken place could be higher as there is evidence that fire suppression activities have taken place without the knowledge of state and federal land agencies. The vast majority of ignitions on the Chugach National Forest are human caused. . Fire occurrence data does not show any large fire activity for at least several hundred years and the size of the standing spruce in the lower end of the Resurrection River drainage attest to this. The majority of the fire starts have been small fires less than .1 acre in size and the majority of these fires have been human caused.

Fire regimes are characterized by frequency, intensity, severity, forest types, and spacing of fire across landscapes patterns over time (Agee1994). Fire regimes help describe the role natural fire plays in the ecosystem. Fire is infrequent and could be severe within the Analysis Area. The average time between fires in these regimes, particularly along the coast, is 200 years or more. Examples of vegetation in this type of fire regime (Fire regime V) are Pacific silver fir, western hemlock, mountain hemlock, subalpine and alpine plant communities. This does not include non-forested areas of rock and ice.

Aquatic Species and Habitats

Reference conditions (pre-1800) for the aquatic resources at this location are basically indefinable because the necessary information is not available. However, based on the lack of roads and easy access it is probably a reasonable assumption that within the Chugach Forest boundaries the reference conditions in terms of stream habitat was not much different than what is observed today. On non-federal lands there has been considerable development and road building which has likely degraded the habitat relative to the reference condition.

The fish assemblage and numbers were likely different under the reference condition than at present. With no hatchery program, the numbers of returning coho and probably Chinook were likely fewer than is currently the case. In contrast, stickleback populations (both threespine and possibly ninespine) as well as certain Dolly Varden char and sockeye salmon populations were probably more robust in the past before they suffered eradication efforts in the 1960s and 1970s in a misguided fish management strategy to enhance coho salmon production in places such as Bear Lake. It is possible this eradication effort, which has long since ceased, resulted in lasting damage to the genetic character and distribution of the targeted species.

Terrestrial Species and Habitats

Reference values are the baseline to determine change in the analysis area and provide a basis for comparison. Reference values are the conditions that would be expected if the analysis area did not have significant human influences. For this analysis, reference conditions generally refer to the prior to the settlement of Seward around 1903. In 1793 Russians were present in the Seward area building a ship named "The Phoenix' and Alaska natives were present. The Russians probably traveled in the analysis area in search of iron and game for subsistence. After Seward was founded, numerous photos show the residents with dead animals from hunting or trapping expeditions including moose, Dall sheep, mountain goat, bear, and numerous small mammals. The census in 1910 notes 438 people in Seward. It is likely there were never high numbers of people in the analysis area until after the Seward Highway was built and paved.

Past populations of wildlife are unknown, except that moose are now present, and historically they were not here prior to about 1850 (personal communication with Tony Largaespada, district archaeologist, 2004. The presence of moose is likely due to extensive expansion of hardwoods from human caused fires at the turn of the century. It is likely that other species that use hardwoods such as lynx and birds have increased, and potentially species such as brown and black bear that prey on moose may have increased as well.

Hunting and trapping pressure by native people, the Russians, and early miners may have influenced populations locally in the past. Impacts to wildlife are unknown, but may have been heavy at times.

Travel routes and trails likely existed in the analysis area in areas similar to what exists today, but with much more rustic conditions and less use than today.

Historic data on vegetation composition and structure is not available from the reference period. More of the analysis area was likely covered in ice. There was significant change in climate during the 1800's (Kreideman 2010). In other areas, and likely in this analysis area, humans impacted vegetation by cutting trees to create homes and other structures, provide fuel, and started fires which reduced large trees and created more early seral hardwoods.

Reference conditions specific to Sensitive, Management Indicator, and Species of Special Interest are discussed in the following sections.

Threatened or Endangered Species

No threatened or endangered species are known to have occurred in the analysis area during the reference period.

Sensitive Species

No sensitive species are known to have occurred in the analysis area during the reference period.

Management Indicator Species

Moose

Very limited information is available to describe reference conditions for moose in the analysis area. No evidence exists suggesting that moose were present on the Kenai Peninsula until 150 years ago (Largaespada, 2005).

Mountain Goat

No quantitative data exists to indicate what reference conditions were for mountain goats in this analysis area. Increased hunting pressure after initial European contact may have reduced mountain goat populations; however, mountain goat habitat has probably remained relatively unchanged. Warming conditions however are likely increasing the extent of forested habitat up mountain slopes, which ultimately will decrease available alpine habitat for mountain goats over time.

Brown Bear

Data on reference conditions of brown bear is very limited to nonexistent. We assume that historic populations of brown bear were higher, and that European contact decreased brown bear populations through habitat loss, hunting and defense of life and property (DLP's), although potential increases in fisheries, moose populations could have increased bear numbers. The more recent increase in recreation in the analysis area has resulted in some habitat encroachment and increased DLP mortalities.

Species of Special Interest

Wolverine

Little to no data exists on reference conditions for wolverine. As with all fur-bearers, populations may have decreased after European contact due to the increase in hunting and trapping, and habitat encroachment by humans.

Northern Goshawk

No quantitative information exists on reference conditions for goshawks. Undoubtedly, goshawks have been impacted by the spruce bark beetle infestation, reducing potential nesting habitat.

River Otter

No quantitative data exist for reference conditions. Reports from the 1920s indicate Peninsula-wide scarcities, more than likely a result of increased trapping pressure after European contact. It is unclear how recreation and increased human use may affect river otter populations.

Lynx

Quantitative data regarding reference conditions for lynx are nonexistent. Reports from the 1920s (Culver, 1923) indicate lynx were widespread on the Kenai Peninsula. As with all fur-bearers, populations probably decreased after European contact due to the increase in hunting and trapping.

Marbled Murrelet

Quantitative data regarding reference conditions for marbled murrelet are nonexistent. It is likely that because of the proximity to the coast, some nesting habitat may have been available in stands of large conifers.

Townsend's Warblers

Data on reference conditions are unavailable. Forest Service surveys from the late 1970s indicate that Townsend's warblers were the most abundant species in older forests and were not abundant in recently burned forests. European contact may have decreased Townsend's warbler populations if older forests were altered, but overall impacts on the population were probably minimal. Forest fires and the spruce bark beetle over the last 100 years have also reduced available habitat over time.

Gray Wolf

No data exists on reference conditions for gray wolf in this analysis area. The wolf population more than likely suffered declines after the influx of European settlers, as hunting pressure of all fur bearers increased at this time. However, wolf populations may have increased with the increase in the moose population beginning 150 years ago.

Other Species of Interest

Black Bear

No information exists on reference conditions. The bear population more than likely suffered declines after the influx of European settlers, as hunting pressure of all fur bearers increased at this time.

Amphibians

No information exists on reference conditions. Climate change has potentially affected the populations or distributions, although they may never have been abundant.

Heritage Resources

Reference conditions are included within the Watershed Characterization section. This section does not apply well to Heritage.

Recreation

The time frame for reference conditions is settlement. Generally, reference conditions for the Salmon Creek Watershed are those conditions that would be present if the watershed were operating without significant human influence. Many of the changes in this watershed are the result of human development. Settlement really began in 1903 when John and Frank Ballaine and a group of settlers arrived to begin construction of a railroad. Prior to that time, the Russian fur trader and explorer Alexander Baranof came to and named Resurrection Bay in 1792. And in the 1890s, Frank Lowell, a fur trader arrived and settled here with his family. However, most of this settlement activity was at the head of Resurrection Bay. Construction of the Railroad changed that. Railroad Construction took place between 1915 and 1923. Seward became an incorporated City in 1912 and developed as the ocean terminus and supply center for Interior Alaska. By 1960, Seward was the largest community on the Kenai Peninsula because of its ice-free harbor. In 1953 the Seward Highway was completed between Seward and Anchorage.

During the 1960s and 1970s, outdoor recreation expanded exponentially nationwide. The Kenai Peninsula was no exception. South-central Alaska's population rose from 50,000 in 1950 to 110,000 is 1970, and from then to 300,000 in 1985. Alaska residents have continually sought out recreation activities in a natural setting, while expanding tourism continues to attract many more visitors to Alaska. The Forest Service expanded and improved campgrounds, trails, and trailheads on the Seward Ranger District during the 1960s and 1970s. This development was partly in response to the effect of the 1964 Earthquake on Seward's economy and an increased public demand.

During the last 30 years, human development in the area has greatly increased especially in the area outside of Seward.

Lands

The United States obtained title to lands in Alaska by treaty with Russia in 1867.[13] Shortly thereafter, the United States began reserving lands from the public domain for military and other purposes. Among the first reservations for conservation purposes in this new territory was a Forest and Fish Culture Reserve established on Afognak Island by President Benjamin Harrison in 1892. The Chugach National Forest was created through a series of Presidential Proclamations, Executive Orders and Public Land Orders that followed, and was combined by Executive Order with the Afognak Island Forest and Fish Culture Reserve in 1908.

In 1909, President Theodore Roosevelt issued an Executive Order that added several lands to the Chugach National Forest, including significant portions of the Kenai Peninsula. Certain southern portions of the Kenai Peninsula, including portions of the project area, remained excluded from the Forest until a 1915 proclamation again changed the Forest boundary, relocating its southern extent within the Salmon Creek watershed to the area around the Milepost Six of the Alaska Railroad. By 1925, the Forest boundary had again been modified to include most lands within the Salmon Creek Watershed. Most lands around the head of Resurrection Bay, however, fall outside the Forest boundary.

In 1904, at the order of Gifford Pinchot, the first Chief of the Forest Service, W.A. Langille surveyed forested lands in Alaska, including lands of the Kenai Peninsula. Although the human population in Seward was sparse at this time (approximately 200 individuals), the Kenai Peninsula was already experiencing the beginning of "a twenty-year boom period involving land, resources, and railroad building."[14] Consequently, lands within the project area were significantly modified at the time the Chugach National Forest boundary was expanded to include the Salmon Creek watershed.

Synthesis and Interpretation

This section summarizes and compares existing and reference conditions for the Salmon Creek analysis area and describes the trends and processes that are occurring through time. This synthesis is important for identifying the capability of the analysis area to achieving management objectives presented in the following sections.

Lands

Land ownership patterns within the Salmon Creek Watershed have changed considerably from reference conditions, due primarily to the fact that the port, highway and railway connect in the project area. Alaska Statehood and the land selections that followed further influenced the area's land status character. Although the uplands of the analysis area were historically federally owned and remain so today, the majority of lands surrounding the road and railway are now state, city, borough, or private lands. Given current landownership patterns, continued cooperation with non-federal land owners will be necessary to meet the goals of the Chugach Land and Resource Management plan for access to National Forest System lands. Residential expansion on nonfederal lands (and associated increases in the use of adjacent National Forest System lands) is anticipated within the project area.

[13] Treaty for the Cession of the Russian Possessions in North America to the United States

[14] Rakestraw, Lawrence W. *A History of the Forest Service in Alaska*. 1981 Reprinted by the USDA Forest Service in 1994 (see p. 37).

Geology Minerals and Soil

Geology and Minerals

This section is not applicable to Minerals and Geology.

Soils

Erosion and mass wasting rates are at near-natural levels throughout the salmon Creek Analysis area due to no management-caused landslides. Several landslides in Box Creek have dammed the deeply incised channels causing floods.

Glacial retreat through climate change is exposing new sediments every year. Soils develop in these sediments in varying amounts of time depending on climate. Generally, lower elevations with a southern aspect develop much more rapidly than on higher, cooler sites. Glacial sediments are often higher in pH than developed soils (Crocker and Major, 1955) and can be rapidly colonized by invasive plants. Depending on how close the newly-exposed sediments are to developed areas or other vectors like trails, they may be prime areas for weedy colonization.

Recreation activities are the only human impacts on the soil resources. OHV activity can have an impact on the soil resource through displacement or compaction. Summer OHV use is allowed only on designated trails in a very small area of the project area. Trails should be maintained to withstand the traffic levels. There are several reported unauthorized OHV trails that access USFS land through private or state land. The extent and condition of these trails are unknown.

Snow machine use is very common in the Analysis Area. Running over snow does not affect soil. The effects to soils occur where there is little snow and the machines end up running over bare soil—generally in the designated trails. Since trails are a dedicated use of the soil resource, they are not detrimentally disturbed (FSM2554) but can cause problems for adjacent areas by eroding. Eroded trails should be rehabilitated and maintained to minimize off trail erosion effects.

The area around Lost Lake receives a lot of pressure from dispersed recreation. Reports of damage due to the high amount of use have driven the need for monitoring. The recreation group began monitoring the impacts during summer of 2010. Monitoring will continue into the future.

Hydrology

This section summarizes and compares existing and reference conditions for the Salmon Creek analysis area and describes the trends and processes that are occurring through time. This synthesis is important for identifying the capability of the analysis area to achieving management objectives presented in the following sections.

Geomorphic Trends

From reference conditions to current conditions, the analysis area remains heavily influenced by glacial activity, dynamic stream channels, and sediment transport. Glaciers shaped much of the area and still result in high sediment production and dynamic shifting outwash channels and alluvial fans in the southern half of the analysis area. Glaciers are no longer present in the northern half of the analysis area, where some of the larger streams are in deeply incised canyons. These high relief narrow valleys have always been prone to landslides, which can cause debris dam outburst floods.

Human Impacts to Water Resources

Human impacts to water resources are very limited on National Forest lands in the analysis area, but are widespread on non-National Forest lands, which are located primarily in the valley floors. Development in the area around Seward and along the Seward Highway corridor has caused substantial alterations to natural stream channel dynamics. Roads and bridges impact natural channel processes and limit channel migration. Levees constructed on alluvial fans prevent natural channel migration from occurring as it naturally would. Development near Seward has altered natural processes of channel function and sediment deposition from natural conditions.

Impacts of Channel Changes and Flooding

The impacts to human developments from channel changes and flooding have been steadily increasing as the area has become developed over the past century. Most of these impacts occur on non-National Forest lands in the area around Seward and along the Seward Highway corridor, where development has occurred on alluvial fan and floodplain features. The need to protect developments from floods has increased, but this becomes a more and more difficult task as more of these floodplain areas are developed. These issues are being addressed through improved mapping and regulation in floodplains, wetlands, and hazard zones. Impacts of channel changes and flooding on National Forest lands in the analysis area are limited to localized impacts to trails, trail bridges, and roads.

Climate

Changes in climate over the last century have had and will continue to have an effect on hydrologic processes in the Salmon Creek analysis area. The current trend in climate change will continue to bring gradual long term changes to hydrologic conditions as a result of changes in precipitation patterns, snowpack, glacial extent, and the condition of riparian vegetation. The magnitude of many of these impacts is unknown, and data are limited. The magnitude of this issue is increasing and will play a larger role in future management decisions.

Vegetation and Ecology

Understanding the changes between reference conditions and current conditions is difficult because limited reference condition data is available for the assessment area. It may be assumed, however, that human causes of change would probably be restricted to human disturbances that are readily observed, as opposed to subtle human alterations such as fire exclusion.

The primary anthropogenic disturbance altering vegetation from reference conditions has been development in the landscape area. Old photographs of the city of Seward show deforestation surrounding the town and Resurrection Bay as trees were cut to construct homes, buildings, bridges, harbors, and for fuel wood in the early 1900's. Today, this area can be considered "second growth" spruce that is probably about 100 years old. Human-caused fire events and mortality from spruce bark beetle have only played a small role in the assessment area in comparison to what has occurred in other areas of the Chugach National Forest.

Management actions affect the landscape by changing the vertical and horizontal structure of vegetation. The effect this has is dependent upon the type of management action. Development has undoubtedly affected the landscape near Seward by deforestation and in promoting the spread of invasive plants—which may out-compete native plants and change the vegetative mosaic in the assessment area. Exotic insects and disease have not yet played a significant role in shaping the current landscape in the

assessment area, but with the possibility of the introduction of extremely destructive species, such as Asian gypsy moth, exotic insects and disease should be considered as possible anthropogenic disturbance. Asian gypsy moth affects about 600 species of conifers (USDA Forest Service 2009) and a host of broad-leaved plant species. This exotic pest, which is indicated as a threat to Alaska, could cause widespread defoliation and possible mortality, especially within the context of synergism with other forest pests, thus creating significant alterations of the landscape.

Botany and Weeds

Ecosystems

Based on studies conducted by the Kenai National Wildlife Refuge ecologists, the vegetation is predicted to shift from one dominated by spruce-hemlock/alpine types to hemlock/herbaceous and wetland graminoid types in the Eastern Kenai Peninsula, including the Salmon Creek Landscape Assessment area (Figure 34). The eastern side would likely remain in the Northern Pacific Maritime biome even with the shifts in vegetation. The changes on the Western Kenai Peninsula are predicted to be much more dramatic with a complete shift from a Boreal Transition biome to an Aleutian Islands biome.

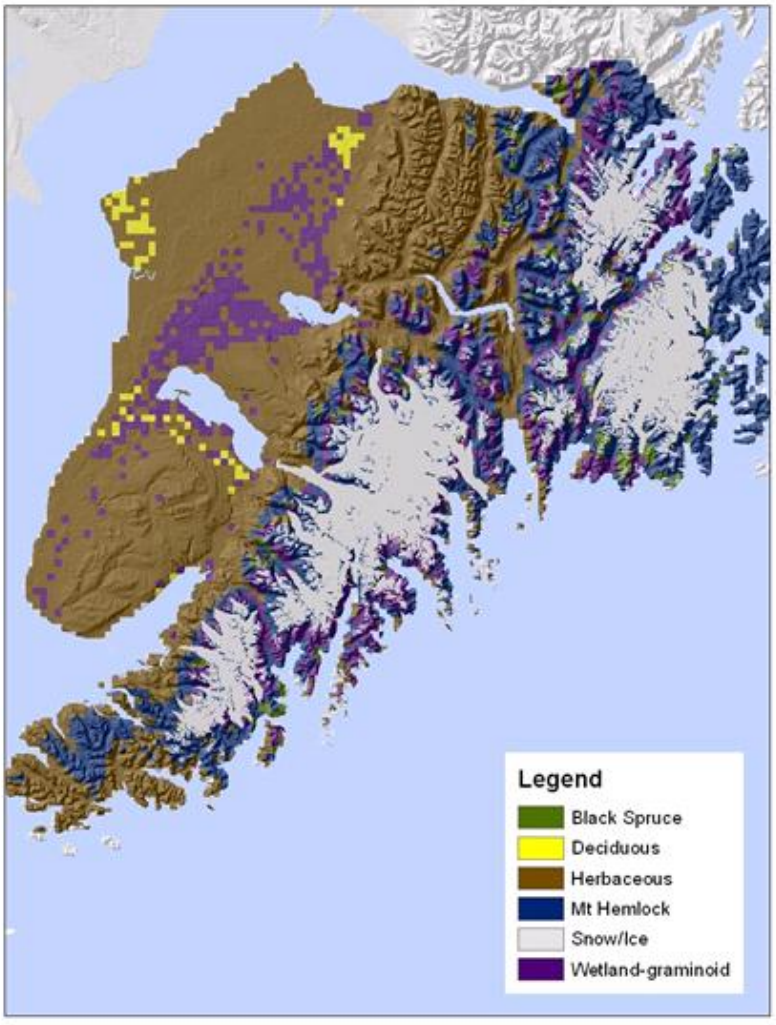


Figure 34. Predicted Land cover in 2099

Non-native Plants

The introduction and spread of invasive plant species is a growing concern in Alaska. Based on existing information, most areas of non-native plant occurrence are in areas of human-caused disturbance such as edges, visitor facilities, trailheads and trails. Non-native plants are rare within natural communities and undisturbed areas. Owing to the relative rarity of invasive plants in the area, land managers of the Chugach National Forest are in a unique position to prevent invasive plant problems before they occur. Prevention is generally much cheaper than control and identifying outbreaks early and responding to them quickly can reduce costs.

Land managers can follow the Chugach National Forest Invasive Plant Management Plan to assist in accomplishing invasive plant management goals. Under this plan, invader sites and new infestations of priority species would be inventoried and brought under early treatment strategies, including containment (prevent off-site movement), control, and eradication as rapidly as possible. Monitoring and annual evaluation would be initiated. Established infestations would be inventoried and managed based on objectives and priorities.

Sensitive and Rare Plants

To date, no sensitive species have been found in the landscape area. This may be a data gap since most of the landscape area has never been surveyed. Additional information is needed to refine and validate the habitat diversity/bioenvironmental model. This would likely include systematic surveys to document the presence and distribution of sensitive plants throughout the watershed in order to protect existing populations and improve predictability of identifying potential habitats identified by the habitat diversity model.

Fire and Fuels

Little reference information is available for fire and fuels in the analysis area, making it difficult to predict how things have changed over time. The vegetation has been drastically altered due to settlement. Little data exists other than photos and historical accounts to give an idea of what the historical Fire Regime Condition Class or fire return interval was. . Physical evidence (snags, charred woody materials) to estimate when, if ever, this drainage has experienced large fire activity has not been discovered. There have been large fires close to the Analysis Area (North Fork Snow River and Resurrection River drainages.) The headwaters of the Resurrection have experienced stand replacement fire events as characterized by the beetle impacted Spruce stands located there. The timeline for such events, especially in coastal areas is measured in hundreds of years. Subsequent research in the drainage may give us an idea of when that happened and when it may happen again.

It is likely that human use in the Salmon Creek Analysis Area has increased the potential for ignitions and the potential for large fires to occur. The railroad increases the likelihood of ignitions as evidenced by documented ignitions along the railroad corridor from Seward to Girdwood. There is evidence in existing fire records to support this potential and ignitions could increase over time as vegetative conditions change Fire records show numerous fire suppression responses in the Salmon Analysis area. There may have been many more fire starts or suppression responses but there is no record of how many abandoned campfires, debris fires, discarded cigarettes, etc., burned themselves out without a response or were suppressed without being documented. In regards to the known number of responses all have been directly tied to human use and all have taken place within ¼ mile of existing roads and trails.

Spruce bark beetle infestation has led to increased risk of fire and a short-term increase in large woody debris recruitment potential in other drainages on the forest. The beetle infestation has raised the risk of wildfire in areas which provide recreation opportunities or access to recreation opportunities. The

increased use of travel corridors by visiting forest users may have an increased risk of fire starts though the impacts of beetle infestation are not evident in the Analysis Area. There is the chance that, if an unplanned ignition were to take place on private lands in the Salmon Creek drainage fire suppression resources could be overwhelmed and fire could be pushed through the drainage by some form of high wind event. The likelihood of this taking place is very small, especially in the hardwood dominated lands in the valley bottom. The areas in question are rated as Full Suppression response. In back country recreation areas some human caused fires have required a suppression response but the total number is well below the volume of responses in the main travel corridors and on private lands. Most of the Analysis Area outside of the private lands and travel corridors is in the Limited Response Fire Management Zone. Responses may be to suppress the fire or simply place it in monitor status for the duration of the fire season

Desired conditions for the analysis area are determined in the Chugach Forest Plan in a broad sense and sound fire management decisions by qualified personnel on a local scale. The analysis area currently meets desired conditions. If the area was to experience spruce bark beetle affects in the future or increasing fuel loads from other factors, then the potential for large wild land fire events to take place would increase.

Fuel reduction efforts while reducing fire risk also have trade-offs in terms of short term effects on air and visual quality in the community of Seward.

Fuels reduction treatments in the lower drainage would be in close proximity to Highway 9, the rail line, and a portion of Exit Glacier road, and could impact travel, especially when conditions were conducive to removal/burning of generated material. Smoke from any burning activities may exceed legal thresholds for particulate volume and duration. Visual impacts to the view shed in close proximity to the analysis area could be substantial and remain for a long period of time after the treatment was done. Much of the material that would be removed may have minimal value, making it difficult to dispose of the removed materials. Large scale burning opportunities here could be limited and costly.

Over time surface fuels will naturally increase in the analysis area due to disease, decadence, and natural events such as wind and insect infestation. Increasing fuels could cause greater fire intensities, more potential for spotting, greater resistance to control, and greater risk to fire suppression resources. Continued growth of the understory would increase the likelihood that ignitions that do occur could transition from a surface fire to the timber canopy. Fire behavior that is more intense than historic fire behavior would be expected to have detrimental effects on vegetation and soils. Resistance to control would be greater than if fuels had been treated. Heavy down fuels would contribute to increased fire intensities, spotting potential, creation of a receptive fuel bed for firebrands to ignite, and extreme fire behavior with the potential to generate plume dominated fire behavior. All of these can create extremely unsafe conditions that contribute to increased risk to fire suppression personnel and the public.

Aquatic Species and Habitats

Because aquatic habitat and fish population data are lacking it is not fruitful to attempt a contrast between reference and current conditions. However, there are several troublesome features concerning the current approach to managing the aquatic resource in this area. Foremost among these is a lack of species and habitat inventory. As noted elsewhere in this assessment, there are considerable human caused modifications that have been made to the existing stream and lake habitat, most of which have occurred on non-federally owned lands. Lacking an understanding of both habitat present in the assessment area and the degree to which it utilized by aquatic species, it is difficult to objectively evaluate the impact of

these human activities on stream habitat. Further, without this knowledge it is also difficult to design and implement appropriate habitat restoration and enhancement projects in a way that benefit target species. This lack of information also makes the assessment of possible climate change impacts mostly an exercise in creative speculation. With better information, the climate change predictions could be shifted from being mostly speculation to something more tangible and practically useful.

The salmon and char that are produced in this assessment area support large and important fisheries. However, without spawner escapement information it is not possible to reconstruct total size of each year's return. As result it is not possible to know what percentage of the fish are being killed in fisheries and not reaching the spawning grounds. There are many examples throughout the world of this type of blind fishery management. Not infrequently it eventually leads to the unintentional over-exploitation of the fish stock and not infrequently to its collapse and that of the associated fishery. In the case of this area, a large hatchery program for coho, Chinook, and sockeye has been implemented to enhance the fishery and numerically allow more fish to be caught. However, since these hatchery fish most likely outnumber wild fish, they confound the assessment as to whether or not the naturally produced populations are self-sustaining. This especially the case since it appears there is no monitoring of the natural population.

In addition, hatchery fish can pose a genetic risk to locally adapted populations and ecologically put at risk other aquatic species. Collectively the impacts may reduce the production of natural fish and impair their genetic capacity to adapt and evolve. A simple inventory of the incidence and distribution of hatchery fish within this assessment area may find that they are in fact at low levels relative to wild fish and the risk is low. However, the opposite could also be true – in which case the productivity and genetic character of indigenous species may be seriously compromised.

As discussed earlier, it is probably an assumption-laden reach to infer that Chinook salmon and Dolly Varden char have been in a state of decline since 1996 based on fishery catch trends. However, this observation should at least be a warning sign that such a decline may in fact be occurring. At a minimum there is a need to explore this question. If upon further analysis it is concluded that a conservation crisis is at hand for one or both of these species, strategies to improve this condition need to developed and implemented. Among these might be tactically implemented habitat restoration/enhancement projects.

Finally, against this backdrop of potential problems and inadequate information, the impact of climate change is new stressor being imposed on all aquatic resources. How individual species will respond is difficult to predict. Some may increase in number and distribution, while others may enter a period of decline and perhaps extinction. Developing a better understanding as to the magnitude and distribution of changes that result from a warming planet will benefit the management of the aquatic resources in that occur in this assessment area.

In addition, a new paradigm for fish management may be needed in the face of climate change. Under this new paradigm the primary objective would be to manage for the maximization of genetic diversity and evolutionary capacity of effected species. The objective would be to foster the greatest rate of genetic adaptation possible for the affected species. Of concern under this new paradigm would be: 1) high fishery exploitation rates that result in reduced population diversity, 2) genetic homogenization and disruption of natural evolutionary processes as result of interbreeding with hatchery fish, and 3) loss of access by fish to a full diversity of habitat types because of human activities that may result in a narrower set of genetic selection pressures which may lead to reduction in a species' genetic and ecological diversity. It is this last factor, habitat diversity, where the Chugach Forest has the greatest role to play. The task should be to ensure that fish have access to a full range of natural habitats within a basin. In some cases this may be primarily take the form of providing passage at road culverts and other human barriers to fish migration. In other instances, it may point to tactically implementing stream

restoration/enhancement efforts that ensure the full diversity of possible aquatic habitats is maintained and fully functional. Finally, it is imperative that monitoring of the aquatic habitats and fish populations be the cornerstone of any climate change management strategy. The rapidity and magnitude of environmental changes that are expected over the next 50 years is unprecedented in recorded history. Natural systems, such as the ones being assessed here, will likely respond in new and unpredictable ways. Entering such a period without a good monitoring system means these changes will not be understandable. Future management initiatives implemented with the goal of responding to these changes without the benefit of an understanding the underlying processes will likely be ineffective and wasteful of limited financial resources.

Terrestrial Species and Habitats

The primary changes since the reference period relate to increases in human population and climate change. Human development and recreational use of the analysis area may increase as human populations increase worldwide. Unchecked, this will continue to stress wildlife through disturbance and continue to reduce or degrade habitat.

Climate change, although not forecasted by current models to make a dramatic difference in the analysis area compared to lands on the western side of the Kenai Peninsula. Changes on the western Kenai Peninsula may cause some wildlife to migrate into the analysis area. Maintaining good habitat conditions and habitat connectivity will be important in the future to maintain habitat for species that may experience loss in other areas. Cooperative efforts should be initiated between the USFWS, NPS and Forest Service to identify habitat connectivity areas.

Increases in Human Population

Increases in the human population occurred after the establishment of Seward in 1903, and the urban renewal funded after the 1964 earthquake. Tourism was also established after 1964 to increase economic opportunity. The development of the Seward Highway allowed access deeper into the analysis area. Increases in the number of people have affected wildlife in several ways.

Development

Prior to the early 20th century, vegetation communities existed in a more or less pristine state, affected only by natural disturbance such as fire, avalanches and seasonal flooding. After the establishment of Seward in 1903, portions of the SE quarter of the analysis area have been continuously developed, clearing vegetation on private, city, state and federal lands for homes, roads, highways, railroad, trails, and facilities. Development expanded after Kenai Fiords National Park was established and Exit Glacier Road was developed between 1965 and 1986. This increased tourism and development increased to support this.

Development has reduced habitat has quantity and quality through habitat destruction, disturbance to wildlife from human activities, increased mortality to animals from DLP's and vehicle or train collisions. Examples include increasing DLP's to brown bear and black bears, and mortality to moose, swans, birds and small mammals from vehicle collisions on the highway and other roads.

Future development will continue to degrade wildlife habitat. Development in floodplain areas can reduce the availability of and affect the functioning of wetlands, which are important nesting and foraging habitat for Trumpeter swans and other waterfowl. Floodplains often support willows which provide moose browse and food, cover and nesting habitat for a variety of species.

Subsistence, Hunting, and Trapping

Increasing human populations have likely increased the demand for fish and wildlife resources for food (subsistence) and furs, but this may be in a more sustained but regulated fashion due to fish and game management. How this has changed animal numbers or species composition from the past is unknown. Current management focuses on increasing moose numbers and will continue to do so.

Tourism and Recreation

Increasing human populations in the analysis area and increasing in tourism in the Seward Area in the last 20-30 years has brought more people to recreate in the Kenai Fiords National Park, the Chugach National Forest including the Lost Lake Trail and Iditarod Trail (camping, skiing, snow machining etc.). In addition, user created trails such as Mount Alice trail and others often originate from state or private land and access Forest Service lands. Public use is hard to regulate or to quantify, and trends of use may be increasing.

Recreation can affect wildlife by disturbance and habitat degradation. Figure 35 shows allowed winter recreation use on Forest Service Lands. Additional recreation occurs on City of Seward and State lands. Recreation activities include winter recreation (snow machining, skiing, snowshoeing, fishing), summer recreation (hiking, biking, flight seeing, fishing and bird watching). . High winter and summer recreation use occurs along the Lost Lake Trail runs through forested habitats and into the sub-alpine and alpine habitats and may affect species noted to occur there. This may affect mountain goats, brown bears and wolverines. High recreation use that is aircraft assisted also occurs on Godwin Glacier, also potentially affecting alpine species such as mountain goats, brown bear and wolves. The Iditarod Trail runs through forested habitats and may affect a variety of species that use spruce/hemlock forests.

Transportation Corridors

Increasing human populations have increased the needs for access and transportation, which has resulted in development of roads, trails, the railroad and regularly traveled corridors used by aircraft (Figure 36). Roads and the railroad, including the Seward Highway, city roads, and forest roads can inhibit habitat connectivity and cause mortality from vehicle and train collisions. Vehicles and aircraft are noisy and can disturb or displace wildlife. The Seward Highway and adjacent railroad may discourage some animals from crossing the transportation corridor, separating their use to one side of the watershed. Trails allow access to recreationists which can disturb or displace wildlife, degrade habitat, increase fire risk in wildlife habitats. Aircraft use the Salmon Creek Valley to travel to the west side of the Peninsula from Seward and for flight seeing activities near Upper Russian Lake and other areas.

These corridors are likely causing mortality to moose, as both the railroad and Seward Highway run through the middle of moose winter range. These corridors also run adjacent to Grouse Creek, which is anadromous. Species feeding on salmon such as gulls bears and other mammals and birds risk mortality from vehicle or train collisions. Many wildlife follow topography and streams or rivers when traveling, so transportation corridors next to these areas may increase risk of mortality.

Climate Change

Climatic changes have been occurring over the past several decades on the Kenai Peninsula. Although long term climate data are limited in the Salmon Creek analysis area, one indicator of long-term climate change is the retreat of Exit Glacier. Exit Glacier has been documented as retreating approximately 1.5 miles since 1815 (Figure 37). Records are not available before that date. It is expected that this trend of increasing temperature will continue in the future, but the magnitude of change over time is unknown.

The Kenai National Wildlife Refuge (KNWR), in cooperation with University of Alaska Fairbanks, used SNAP data (Scenario Network for Alaska Planning) to create a simple model to forecast climate change effects on vegetation through 2099 on the Kenai Peninsula (personal communication with Dawn Magness, USFWS GIS specialist, 2010). Figures 38 and 39 show current conditions and predicted trends.

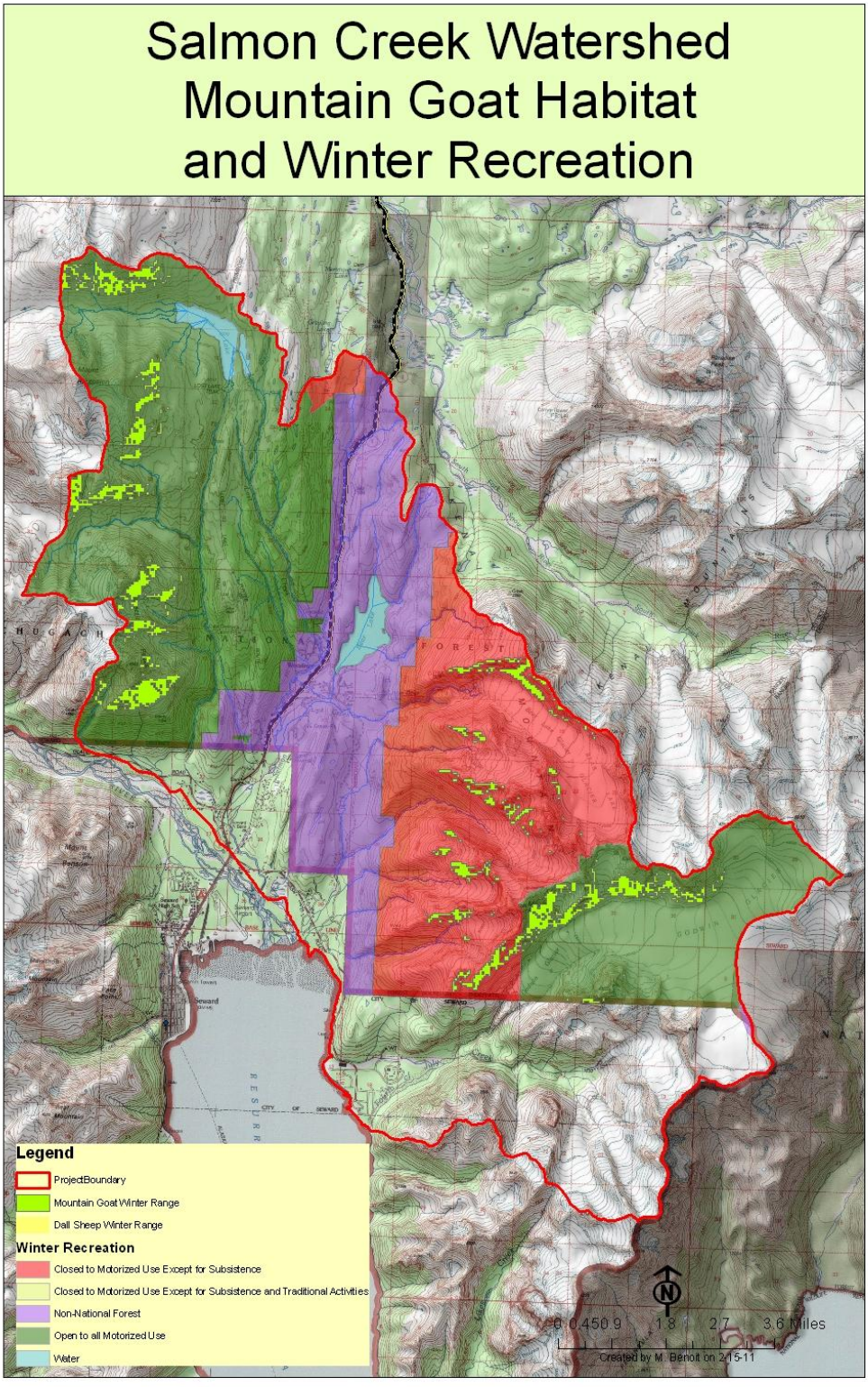


Figure 35. Wildlife Habitat and Winter Recreation

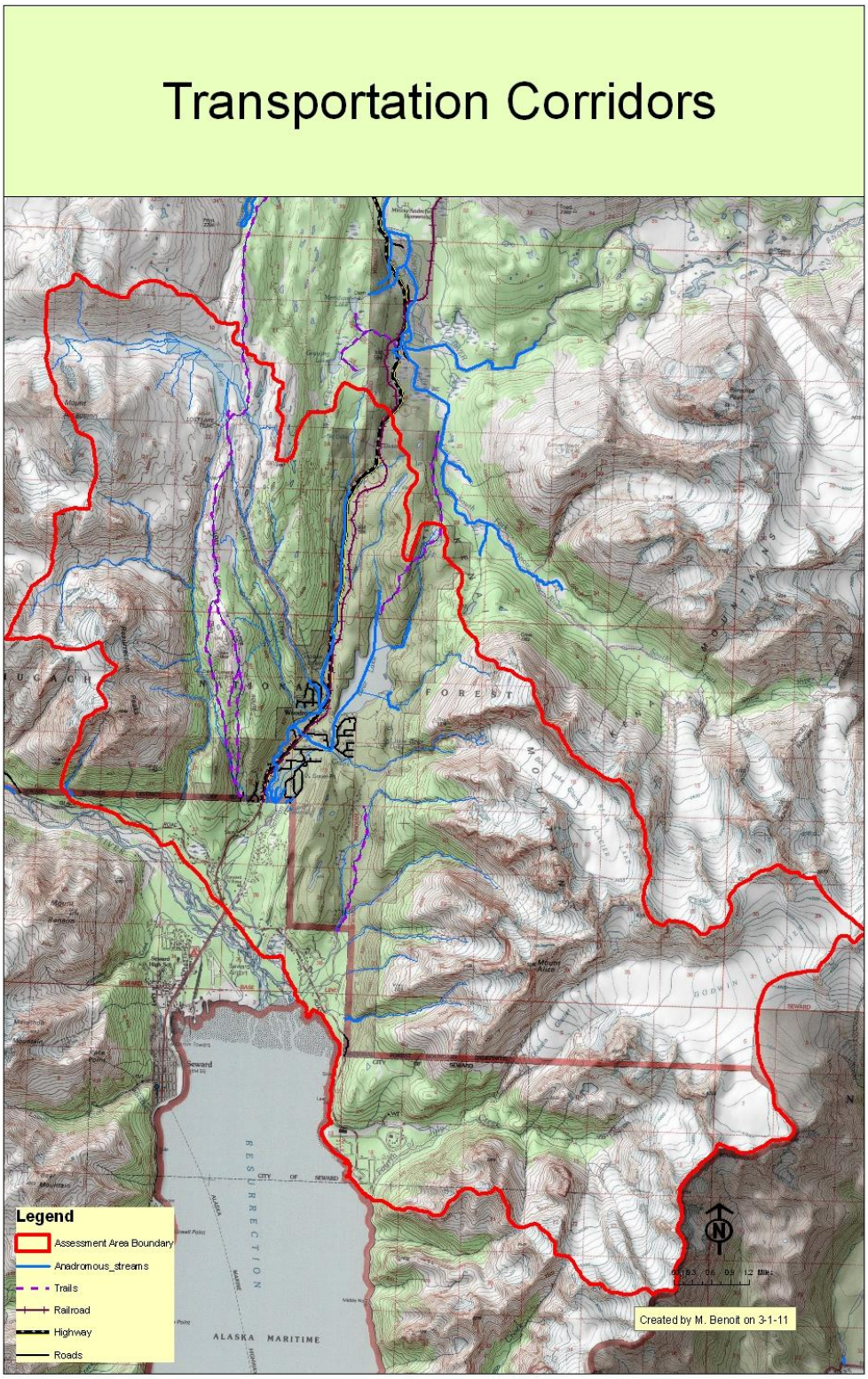


Figure 36. Transportation Corridors

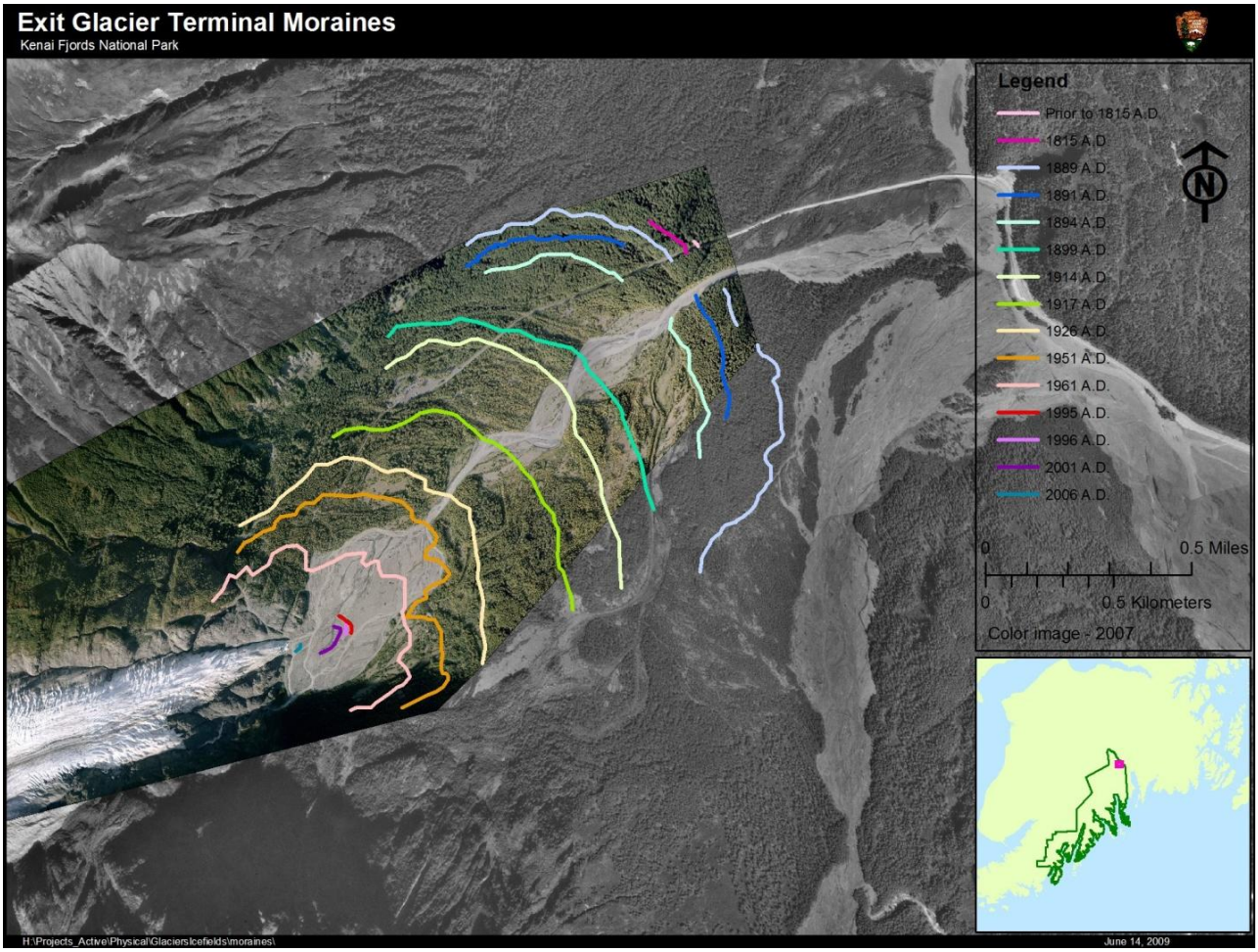


Figure 37. Exit Glacier

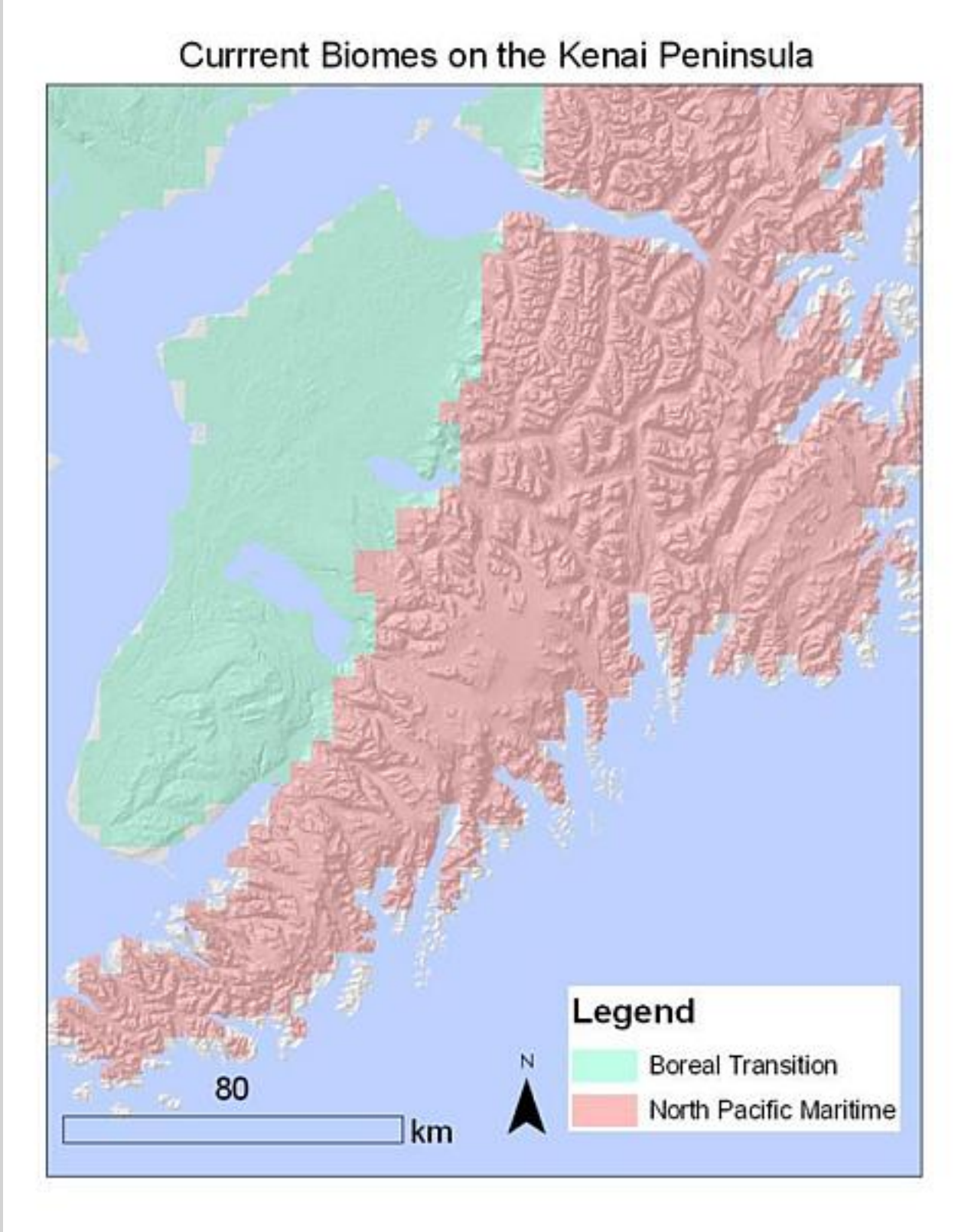


Figure 38. Current Biomes

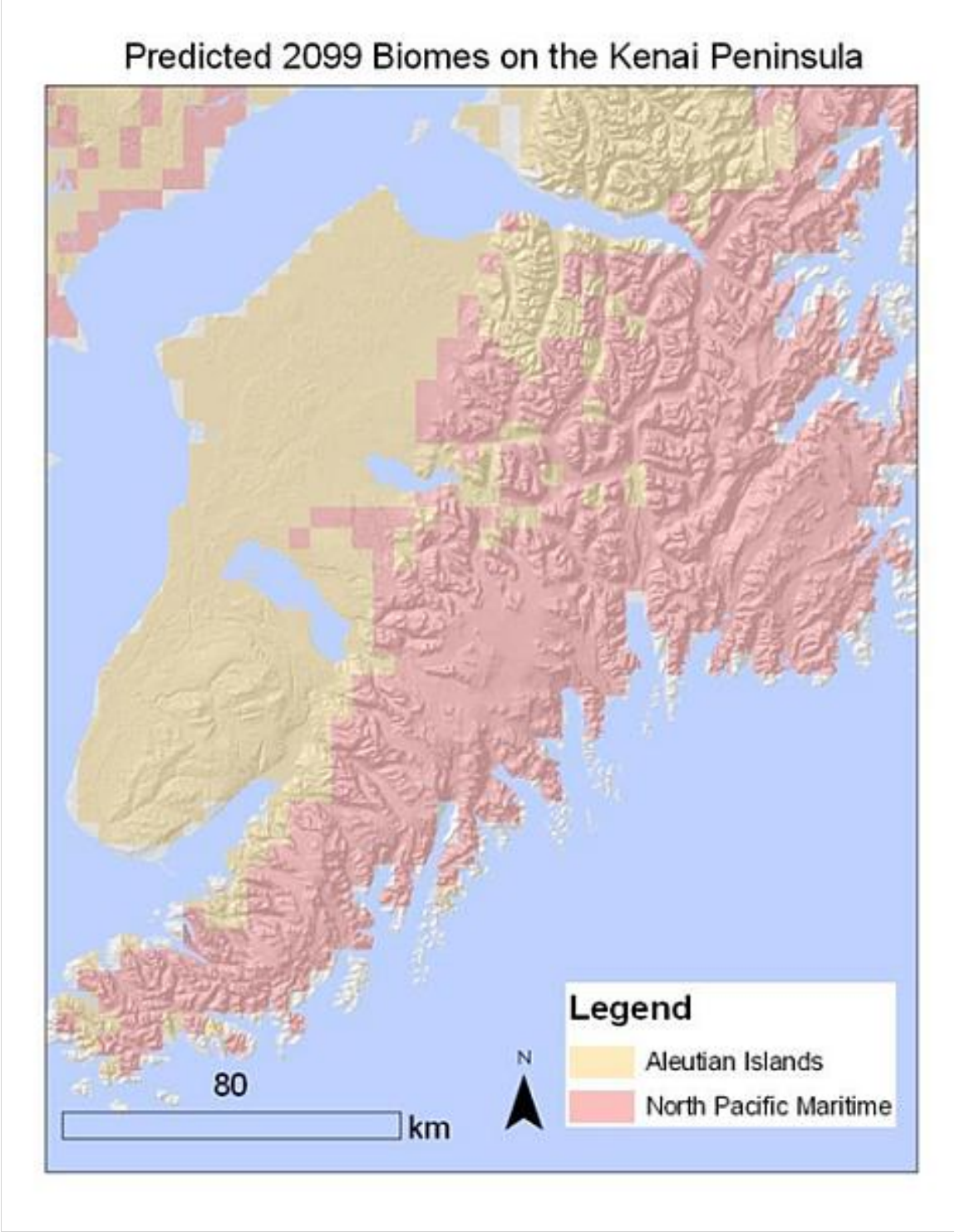


Figure 39. Predicted Biomes

Based on this model, climate change will likely affect the distribution of vegetation types on the landscape over time. Forested areas may become more abundant and alpine and sub-alpine areas less abundant. The model indicates that on the western side of the Kenai Peninsula, the wildlife refuge will change from boreal transitional forest to the Aleutian Islands Biome, losing alpine, all conifers, most

hardwoods and shrubs. It will have expanding wetland-graminoid areas, herbaceous areas, and mountain hemlock. The eastern side of the Peninsula, including the Salmon Creek analysis area will likely remain more stable as coastal rainforest (North Pacific Maritime Biome), but hemlock (vs. Sitka spruce) will predominate. The analysis area may likely experience a loss of alpine habitat as hemlock expands (See Figures 15 and 16). On the KNWR, forested areas have been increasing at a level of 10 meters/decade.

Changes in vegetation types and structures may affect wildlife habitat, benefiting some species, and reducing habitat for others. On the KNWR, the USFWS predicts that climate change could cause extirpation of 98% of species, and that 2% would spread dramatically. It is likely that new conditions will pave the way for range expansions or reductions, or exotic species introductions (personal communication with John Morton, USFWS biologist, 2010). Warming temperatures may cause drying of water sources and wetlands, and reductions of snow and ice fields and glaciers due to melting.

Changes in biomes are predicted on the KNWR lands east and southeast of Skilak Lake from North Pacific Maritime (similar to the Salmon Creek analysis area) to Aleutian Island Biome by 2099. This may cause some species to migrate into the analysis area to find similar habitats if they do not adapt to new habitat conditions.

Although the extent of use is unknown, local reports from pilots and Godwin Glacier Dogsled Tour operators indicate that bears use snow fields or glaciers as regular travel routes and that wolves and moose are sometimes spotted. Caribou, mountain goats and Dall sheep use snow fields as refugia from insects and summer heat. If alpine areas decrease in area and availability, mountain goats may experience loss of habitat. The extent or significance of these effects is unknown. As alpine habitats decrease, animals may be stressed. Disease, parasites and other health issues may add further stress to alpine species. Dall sheep and mountain goats are showing evidence of disease and parasites in other areas outside the Chugach National Forest (personal communication with Tom Lohuis, ADFG). Causes and extent are unknown.

Warming temperatures may affect fish that depend on certain water temperatures for survival. Salmon in particular provide food at various stages to a wide variety of species and contribute to terrestrial nutrients. Warming temperatures may reduce suitable habitat for fish or change the species composition, creating a variety of effects on the wildlife species that depend on them for food.

Changing conditions may cause shifts in migration patterns, causing some species to leave or arrive earlier or later (personal communication with John Morton, USFWS 2010).

Climate change has likely caused the epidemic spread of the spruce bark beetle on the Kenai Peninsula (personal communication with Ed Berg, USFWS, 2009) which has killed many of the mature and old growth trees and increased fire risk in wildlife habitat.

Spruce Bark Beetle outbreaks may increase to affect mature vegetation on a large scale. Loss of larger trees could affect species that use them for nest structures such as northern goshawks and other raptors.

Wildfires could increase if beetle killed trees or wind throw increased, as fuel loads and temperatures increase, also causing loss of mature habitats. Access to these areas will be difficult, reducing feasibility of fuel reduction treatments.

Threatened, Endangered or Sensitive Species

The analysis area currently does not have threatened or endangered, or sensitive wildlife species or habitats, and it is unlikely that they occurred in the analysis area during the reference period because these species are marine mammals or birds.

Management Indicator Species

Changes in brown bear populations are unknown. Populations have likely declined through habitat loss, hunting and defense of life and property (DLP's), but potential increases in fisheries and moose populations could have increased bear numbers as well. Increasing recreation in important habitat areas can cause disturbance, habitat avoidance, or increase the potential for bear human interactions. Recreation (camping, hiking is occurring along the anadromous streams used for foraging. Bears use a wide variety of vegetation types for traveling, feeding, resting, foraging, and denning. While bears may adapt fairly well to some of these changes, climate changes may have greater effects on some of their prey species such as fish which depend on certain water temperatures, and alpine or sub-alpine species such as mountain goats and marmots.

Current populations and trends are unknown, but it is likely that with human related and climactic pressures, bear populations are and will continue to be lower than during reference conditions.

Mountain goat numbers may have been reduced with increased hunting pressure after initial European contact. Since then, with regulated hunting and game and fish management, and little development in alpine areas, goat habitat and numbers have probably remained relatively stable. Climate change may impact goats in the future by reducing habitat availability, causing stress which may reduce ability to fend off disease or parasites.

Moose may have increased after the turn of the century when human caused fires or humans cutting trees for development may have created habitat for them, but now numbers are declining over time with forest succession. The development of the highway and railroad through the middle of moose winter range increase mortality from collisions. Development in flood plain areas and destruction of wetlands or their ability to function contribute to declining moose habitat. Management continues to try to increase moose numbers for subsistence, recreation, and watchable wildlife. In the long term, climate change and human caused habitat destruction may reduce the availability of hardwood browse which is already limited as hemlock becomes more dominant. If this occurs, and less browse is available, reductions in moose populations may occur. This would, in turn, affect predator populations of wolves, wolverines, and bears.

Species of Special Interest

Fur-bearer populations of bear, wolf, wolverine, lynx, river otter and other species may have decreased after European contact due to the increase in hunting and trapping, and habitat encroachment by humans. Since then, Fish and Game management does its best to regulate population changes. Continuing human development, recreation, and roads and attractants such as the Bear Creek Weir and unsecured garbage in Seward will likely continue to affect individuals negatively, and climate change may have varying effects on these species and their habitats and prey species.

Forested habitats may become more abundant, increasing habitat for northern goshawks, and some migratory birds. Changing forest types and potential impacts to fish may affect a whole suite of species that depend on salmon. Bald eagles, for example may lose nesting habitat and experience a reduction in food.

Heritage Resources

Continue to identify new sites through new cultural resource surveys. Evaluate new and existing sites for National Register eligibility, so that available resources can be focused on protection and preservation of significant sites that are negatively affected. Take account of high-altitude resources and the impact of

climate change on these resources, through survey of high-altitude areas through Section 110 or NFIM survey projects.

Recreation

Outdoor recreation is the fastest growing use on the national forests and grasslands across the United States, continuing a steady trend since before the 1950s (Cordell, 2004). Population has continued to be the major driver of outdoor recreation participation growth in this country (Cordell 2004). The Kenai Peninsula Borough is one of the more populated and faster growing regions of Alaska. Recreation growth, on the Chugach National Forest, is likely to disproportionately increase the number of recreational users increase. Currently, well over 90 percent of Americans participate in at least one outdoor recreation activity (Cordell 2004). Estimates of recreation days occurring in forest settings from 2000–2001 show (in order) walking for pleasure; viewing/photographing natural scenery, birds, flowers, and wildlife; day hiking; sightseeing; driving for pleasure; mountain biking; and visiting a wilderness or primitive area (Cordell 2004).

Following suit with national recreation trends, recreation use in the Lost Lake portion of the Salmon Creek Watershed has increased significantly since the early 1990s Events like the Breath of Life Run over the Primrose/Lost Lake Trail System has heightened awareness of the area for mountain running and spectacular scenery.

Within the past 50 years, the concept of recreation itself has changed with the advancement of technology to include a wider range of recreation experiences. The development of new technology which is lighter in weight and more durable such as full-suspension mountain bikes, waterproof hiking boots, rain gear, synthetic clothing and sleeping bags, more versatile snowmachines and ATV's, four-season camping tents, backcountry telemark gear, and improved aircraft have allowed recreationists to pursue new activities in the backcountry which are longer in duration and can be carried out year-round. New technology in the form of sport-utility vehicles, larger recreation vehicles (RVs) and large motor homes has changed the original concept of front-country recreation that was envisioned for the recreationists of the 1960s and 1970s.

Many of the Forest Service recreation facilities built in the 1960s and 1970s are not adequate for today's recreationists. These are being upgraded, replaced, or rebuilt to conform to the needs and desires of today's recreationists and to comply with current Federal, State, and local laws, regulations, and guidelines. New facilities such as backcountry cabins, yurts, huts, campgrounds, and campground expansions are being built, planned, or proposed on National Forest System lands to meet the increased demand for recreation.

The overall result of new or modified recreational activities and the increase in the number of recreation visitors to the Kenai Peninsula has led to many new opportunities and challenges. The large number of visitors using the Kenai Peninsula has contributed to and changed the economy of many Kenai communities, but has also contributed to the deterioration and loss of ecological and cultural resources and facilities.

Watershed Area Recreation Trends: In general, an increase in outdoor recreation use can be assumed as the population grows. Alaska residents are also known for their propensity to recreate throughout the State. Alaska is also a destination location for many recreational enthusiasts from out of State. The Salmon Creek Watershed will continued to experience moderate recreation growth, especially in the areas adjacent to the road, trail and around the lakes.

Recreation Conflicts: Generally, the main sources of recreation conflicts are adverse interactions between different user groups (i.e., Skiers and Snowmachiners). These conflicts can occur because recreation users feel either threatened or their expectations in the experience diminished. The most prevailing example of recreation conflict, within the Salmon Creek Watershed, is between motorized and non-motorized users both in the winter and summer. Other conflicts between users are bicycles and vehicles on the road and mountain bikers and hikers on the trail.

Desired Condition, Opportunities, Management Strategies, Data Gaps, Monitoring and Research Needs

This chapter discusses desired future conditions, considering the differences between reference and current conditions. Desired future conditions consider what is feasible today and current management direction. Opportunities, management strategies, data gaps, and monitoring and research needs are presented for each desired future condition as means to achieve the desired condition. Table 17 displays a summary of these things for each resource.

The following incorporates management direction from the Revised Forest Plan, (page 3-13) (USDA Forest Service, 2002a).

Table 17. Opportunities, management strategies, data gaps, and monitoring and research needs for each desired future condition by resource

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Lands			
▪ **Follow forest plan management prescriptions for the area.**			
• Where access needs involving new roads or recreation areas occur within the project area, consider appropriate opportunities for acquisitions of lands or interests of lands. • Identify the Forest Plan prescription for these areas and determine whether the opportunity is consistent with Plan direction. Where possible, identify opportunities for road or recreational site development within the "fish, wildlife, and recreation" prescription areas rather than the "backcountry" prescription area. • Seek opportunities to work with highway planners and engineers to locate turnouts, provide safe crossings for the public and wildlife, protect habitat, plan for trailheads, and provide bicycle lanes and pedestrian paths. • Look for opportunities to collaborate with the Kenai Peninsula Borough Flood Plan Task Force and the Kenai Mountains-Turnagain Arm National Heritage Area Corridor Communities Association.	None identified.	• Emphasize acquisition of lands and interests in lands through willing parties that provide public access to National Forest System lands. • Review land classifications affecting the remainder of the project area and adjacent lands including: • *Kenai Area Plan*, Alaska Department of Natural Resources, Division of Mining, Land &Water, Resource Assessment & Development Section (2001). [15] • This plan discusses the designation of Upper Resurrection Bay and watersheds as an "Area Meriting Special Attention" and includes the drainages of and Salmon Creek. Collaborate in interagency planning effort to assist Seward in realizing its community development goals." • *The Seward Highway Scenic Byway Corridor Partnership Plan* (1998) • Participate in highway planning and improvement efforts. • Survey un-surveyed boundaries in the project area.	None at this time

[15] http://dnr.alaska.gov/mlw/planning/areaplans/kenai/pdfs/master_KAP.pdf

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Geology, Minerals, and Soils			
▪ **All lands not expressly withdrawn from mineral entry for recreation areas, campgrounds and similar developed sites are and should remain open to mineral entry.** ▪ **Assess mineral materials sites if a need is identified.**			
• National Forest lands within the analysis area are open to mineral entry and location (locatable minerals) if not expressly withdrawn. • Opportunities exist for development of sand & gravel and rock, primarily in the roaded valleys to support local residents and local infrastructure projects.	• Develop 10 years mineral material management plan for roaded areas of the Kenai Peninsula.	• Process locatable submittals promptly according to 36 CR 228A and FSM 2810 regulations. • Consider all reasonable requests for Mineral Materials under 36 CFR 228C and FSM 2850 regulations.	• Investigate possible sites for development of mineral materials to support the needs of local residents and infrastructure construction and maintenance.
Soils			
▪ **Soil resources will be the result of natural processes. Soil resources will provide natural soil ecosystem functions, processes, and services such as soil organism habitat, biogeochemical cycles, analysis area stability, water storage and release, and above and below ground biodiversity as compared to a natural reference.**			
• Work with other Forest Programs, agencies, and landowners to managed soil resources to maintain or improve soil quality and function. • Monitor unauthorized OHV use along NFS lands that border NNFS lands. Work with Law Enforcement and Education and Outreach to reduce the use of these trails. • Work with the recreation group to monitor and provide solutions to OHV and dispersed recreation issues. H • Help develop a monitoring plan that identifies and classifies the extent of disturbance around Lost Lake. • Provide input to a program that hardens surfaces or otherwise minimizes impacts to the soils and vegetation resources. • Monitor any trails with known maintenance problems and work with the trail crews to rehabilitate identified problem areas.	• Terrestrial mapping is critical to help guide future management needs. Develop Terrestrial mapping products such as: • Terrestrial Ecological Unit Inventory (TEUI) mapping (USFS, 2005 that includes landform, soils, and vegetation with interpretations for a variety of resources. • Traditional Soil mapping is also actively conducted by the Natural Resource Conservation Service (NRCS). • A landslide or mass wasting inventory could be completed using existing resources on the forest. The new 20-meter DEM or the Lidar information coupled with the orthoimagery in GIS would be more than adequate to begin a landslide mapping project.	None identified	• Begin a Terrestrial mapping program on the Chugach National Forest that ties soils with vegetation and landform together • Monitor OHV use across the analysis area. Document their impacts and mitigate as needed. The technology can be relatively low-tech, varying from Come up with a methodology for working on the dispersed camping around Lost Lake. • Maintain trails using current BMPs. There is a new suite of draft BMPs that should be tested and new monitoring protocols followed (USFS 2011). • Monitor the Lost Lake area and help guide solutions that minimize further impacts to the soil resource. Examples include but are not limited to, building tent platforms, and designating areas for camping, closing the area to overnight camping.

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Hydrology			
• Contributions to greenhouse gas emissions will remain limited, and riparian ecosystems will have high resiliency to the effects associated with climate change. The condition of water resources will result primarily from natural processes. Stream channels will function naturally in terms of hydrologic function, bank stability, riparian condition, water quality, and aquatic habitat. ▪ Streams and other water bodies will have acceptable water quality, as defined by the Alaska State water quality standards (Alaska Department of Environmental Conservation, 2009). • A controlled balance will exist between allowing natural stream processes to occur and controlling these processes to protect human developments. • Contributions to greenhouse gas emissions will remain limited, and riparian ecosystems will have high resiliency to the effects associated with climate change			
None at this time	• Long term stream flow data for streams in the analysis area are needed for assessing flood hazards and the long term impacts of climate change. • Long term water quality data for streams and lakes in the analysis area are needed for assessing the long term impacts of climate change. • The National Hydrography Dataset (NHD) and Watershed Boundary Dataset (WBD) are inaccurate in places and need to be edited	• Ensure that Forest Service projects comply with all applicable Best Management Practices (BMPs), as defined in the R10 Soil and Water Conservation Handbook (USDA Forest Service, Alaska Region, 2006), to protect water quality. • Work with State and local organizations on developing the best ways to address the flooding issues in the Seward area while retaining natural stream function.	• Work with State and local organizations to better understand flood dynamics and stream channel function in the area, and how floods may impact developed areas. • Establish long-term gauging stations in the analysis area to measure stream flow and water quality parameters to better quantify hydrologic changes that are occurring as a result of climate change.
Vegetation and Ecology			
Desired future conditions for vegetation should be driven by the standards and guidelines listed in the Chugach National Forest Land and Resource Management Plan for each management area in the Salmon Creek Landscape Assessment area. The management areas in the assessment area are Backcountry and Forest Restoration. • Backcountry – natural appearing landscapes mostly late successional forests; largely unaffected by human activity, however, vegetation management or wildlife projects are acceptable • Forest Restoration – multiple-use; managing and restoring plant communities in a mosaic of cover types with age classes ranging from early to late successional			
		• Coordination with wildlife biologists to determine desired species and structures that best meet the needs for wildlife management. • Consultation with the State of Alaska to determine if projects exist on state land in the assessment area.	

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Botany and Weeds			
▪ **The desired condition would be natural habitats in proportions that would exist under natural processes.**			
• Update the bioenvironmental model. New data and updated tools can be used to develop sensitive species conservation assessments, which are important tools used in the management and conservation of rare species.	• Most of the area has not been surveyed for sensitive plants.	• Revise the bioenvironmental model to reflect recent changes to the R10 Sensitive Species List. • Conduct sensitive plant surveys in areas with high potential habitat based on a revised bioenvironmental model.	• Conduct surveys to better understand the presence and distribution of sensitive species in the landscape area.
▪ **The desired condition would be a landscape where non-native plants remain restricted to areas of human disturbance and do not encroach into natural habitats.**			
• Prevent non-native plant species from spreading away from areas of human disturbance, therefore keeping natural areas free of non-native species. .	• Trend data of known non-native plant infestations.	• Develop management strategies based on the CNF Invasive Plant Management Plan and the Guide to Prevention Practices • Control existing populations, before they spread and new infestations become established. • Evaluate invasive plant risk during project planning and mitigate to reduce risks.in site plans, contracts, and permits, as appropriate. • Use natural re-vegetation methods where seed source and site conditions are favorable. • Use native plant species in re-vegetation/restoration projects when natural revegetation conditions are not favorable Use plant materials from the local environment to maximize adaptation and maintain local genetic composition. • All hay, straw, mulch, or forage used should be free of invasive plant species. This includes materials used for mulching, erosion control, rehabilitation, or other uses, by agency personnel, permittees, or contractors.	• Monitoring and annual evaluation should be initiated. • Established infestations should be inventoried and managed based on objectives and priorities. • Where monitoring is needed, it should be planned to continue for at least five years on a scheduled basis. This information should be incorporated into project planning documents, including NE

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Heritage			
▪ **Greater coverage of the landscape assessment area by cultural resource surveys. More cultural sites evaluated for National Register eligibility.**			
• Project work (section 106), general research (section 110), monitoring (NFIM).	• Where Forest users are focused to identify where negative effects to cultural resources are most likely.	• Forest Plan site management prescriptions.	• Need greater survey coverage.
Aquatic Species and Habitats			
Aquatic resources are managed based upon an empirical understanding of: where species occur, their relative abundance, and their response to stressors such fishing and the availability of varied and properly functioning aquatic habitats such that all indigenous species are self-sustaining at full system potential.			
• Work collaboratively to inventory aquatic species present in the assessment area • Assess the potential genetic and ecological impacts of hatchery fish on wild populations and associated aquatic ecosystem. • Determine if Chinook salmon and Dolly Varden char are in decline. • Work collaboratively to inventory aquatic habitat in the assessment area. • Assess the impact of climate change on the status and management of fish and other aquatic resources in the assessment area. • Determine strategies that will reduce interactions between hatchery and wild fish without causing undo disruption to hatchery programs. • Identify opportunities for stream restoration/enhancement that are actionable now or in the near future. • Identify locations where there are significant opportunities for habitat restoration or enhancement.	• Species composition, relative abundance, distribution, and habitat use. • Sub-population structure-genetic heterogeneity or identification of demographically independent reproductive units. • Where hatchery fish spawn and what fraction of the total spawning population do they represent. • Determine the ecological impacts of hatchery fish on other aquatic species. • Determine if Chinook salmon and Dolly Varden char are in decline and assess factors that might be causing this decline. • A measurement of the intrinsic productivity and variation of aquatic habitats. • Identify core production areas for production and sustainability of each species. • Assess how climate change will impact stream hydrology spatially and seasonally.	• Close the aquatic resource data gaps identified in this assessment with the appropriate information and analyses. • With partners develop and implement a means to maintain a long-term monitoring of aquatic species and associated habitats. • Identify and implement habitat restoration/enhancement projects that tactically benefit specific opportunities to improve the production and diversity of key species. • Encourage a shift in management paradigm from the current one based on numbers of fish produced to one where the primary goal is to maximize the evolutionary capacity of species to respond to the impacts of climate change.	• Thorough inventory and monitoring of aquatic resources • Investigate the genetic and ecological impact of the large hatchery program in the assessment area and potential risks to the resilience of several species. • identify and develop the research needed to support the closing of the data gaps identified

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Recreation			
Manage most federal lands for undeveloped, dispersed non-motorized recreation during the snow free months. The Iditarod Trail between Nash Road and Bear Lake will be managed for off highway motorized use. During the snow season the federal lands west of the Seward Meridian are open to over snow vehicle. Federal lands in the east mountains are closed to winter motorized use. We will continue to work with both State and Borough agencies on issues in the development of the Iditarod Trail. The Lost Lake and Clemens Cabin Trails will be maintained at a level 3 development scale. Lost Creek Trail will be maintained at a development level 2 for winter use and closed to motorized use year round. Tiehack and Mount Alice Trails will be maintained at level 1. Grouse Lake Lands are EVOS Lands with development restrictions on them. But we will monitor site use on these lands. Camping will be limited to 14 consecutive days. We will maintain the Lost Lake Trailhead throughout the year. The Dale Clemens Cabin will be maintained to standard and be operated under the National Reservation Service. No other facilities are planned.			
• Lost Lake Trail Facility developed for recreational use needs to provide access for people with disabilities. • Develop a summer trail in the vicinity of the winter snow machine trail to wetlands that are being impacted by foot traffic. This will also create a loop trail back to the trailhead from the summer trail. • Develop management strategies to decrease use conflicts between different user groups. •	• Visitor Use - a visitor use study is needed to better understand public use. Include in the study the types of recreational use and where it occurs within the watershed.	• Seward Scenic Byway –within the Seward Highway Corridor , follow guidelines for the Seward Highway Corridor Partnership Plan. • Iditarod National Historic Trail – Continue trailhead developments at Nash Road and Bear Lake. Coordinate development with the State of Alaska, Kenai Peninsula Borough and Iditarod Trailblazers. • . Acquire easements where necessary on Borough Lands in the Little Bear Lake area. Maintain and improve the trail system with assistance of the Seward Iditarod Trailblazers. • Other Trail Developments - Work with the Borough and the State to develop a plan for managing Grouse Lake. Incorporate a potential trailhead for the Old Lost Creek Trail off of the Grouse Lake Road. Develop this trail into a non-motorized winter access. • Develop a plan for managing campsites around Lost Lake. Maintaining a diversity of recreational opportunities and experiences in the watershed is recommended to better meet the needs of a diverse public, i.e., providing low use, solitude experiences on the east	• Monitor all recreation use in the watershed. • Monitor visitor use to ensure that impacts to resources are avoided or minimized and assure that the recreation experience remains positive. • Monitor resource damage on the Tiehack & Mount Alice user trails.

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Fire and Fuels			
The predominant conditions on the Chugach National Forest will be those that result from natural processes. Conditions that result from active management or restoration will be present in selected locations (USDA Forest Service, Chugach National Forest, 2002a, pg. 3-13).			
• Apply Fire Regime Condition Class (FRCC) or other models to determine fire risk, fire return intervals, potential fire spread, and strategies to deal with fire in the analysis area. • Include a fire use program within the limited suppression boundary to allow natural fire to play a role in shaping the ecosystem while reducing impacts and costs associated with fire suppression activities. • Fire prevention signs at trail heads and road side stops could raise awareness of fire danger with the public.	• Fire regime condition class (FRCC) mapping of the project area to ascertain departures from historic levels. • Fuel characteristic classification system (FCCS) mapping to determine the rate of spread and severity of fire within the project area. • Stand data for input into fire behavior models and future treatment areas near highways and homes. • Current digital elevation models and 1-meter digital color orthoquads are needed for future limited fire suppression strategies or wild land fire use for resource benefit planning. • Accurate weather observations and patterns are needed within the Salmon Creek Analysis area to manage fire under appropriate fire suppression strategies.	• Restoration activities, such as prescribed fire and mechanical treatments and small-scale forest management activities along the road corridors will create opportunities for the utilization of forest products. • Prescribed fires on a limited basis each year for fuel reduction, improvement of wildlife habitat and restoration to desired vegetative conditions • Maintain smoke levels within state standards for particulate material, except when catastrophic fires occur.	• Monitor the effects of increased use and fire occurrence within the analysis area. • Monitor first order and secondary fire effects of prescribed and natural fire within the project area.

Opportunity	Data Gap	Management Strategies	Monitoring and Research Needs
Terrestrial Species and Habitats			
• Bear/ human interactions are minimal, and the potential for wildlife habituation of bears is low throughout the analysis area and particularly in the Seward area • Disturbance to wildlife from aircraft and summer and winter recreation is minimal or within an acceptable range. • Wildlife populations are healthy and support a variety of uses including watching wildlife, subsistence, sport hunting, and other values. • A diversity of vegetation types and structures exists to provide a wide range of habitats for wildlife in approximate amounts as listed below. • Early seral hardwoods exist away (1/4 mile) from roads and the highway, and within or adjacent to moose winter range.			
• Collaborate to reduce attractants and improve education to reduce DLP's and dangerous encounters between humans and bears in cooperation with ADFG and the Seward Wildlife Community Conservation Program. • Collaborate with local citizens to identify marbled murrelet nest sites in the Grouse Lake area. • Increase awareness of potential impacts from aircraft on mountain goat, and brown bears with outfitter/ guides, air taxis, and flight instructors, and ask for voluntary compliance with recommendations	• Identify current human use in the Lost Lake are and acceptable threshold limits. • Determine mountain goat population trends in cooperation with ADFG. • Determine overlap of snow machine use with mountain goat winter range. • Inventory and monitor potential impacts from recreational activities on Mountain Goats and bears in the Lost Lake area and near Godwin Glacier. • Brown bear population size and structure, spring foraging habitat for sows with cubs, primary summer feeding habitat, travel corridors and winter denning habitat need to be identified or verified • Extent and impacts that floatplanes , flight seeing, and aircraft assisted recreation activities are having on wildlife, particularly bears, and goats in the Lost Lake and Godwin Glacier areas. • Climate change impacts on alpine vegetation. • Moose numbers and how the highway and railroad might be affecting moose habitat and moose mortality. • If and where marbled murrelet nesting habitat-exists.	• Gather data on the overlap of human use and mountain goat populations in the Lost Lake and Godwin Glacier areas. • Collaborate and plan habitat connectivity from USFS and NPS lands to the USFWS lands to provide travel corridors for species as habitats change due to climate change.	• Monitor current summer and winter recreation use in the Lost Lake area and on user developed trails to determine trends and acceptable threshold levels • Monitor goat numbers and current aircraft (flight seeing and float planes) on Godwin Glacier to determine trends and acceptable levels of use. • Monitor changes in alpine habitat over time to determine if climate change forecasts are accurate. • Monitor current nutritional condition, and health, and population trends of and mountain goats in the analysis area? • Monitor changes in vegetation in alpine areas and potential effects on Mountain Goats.

Recommendations

Lands

- Emphasize acquisition of lands and interests in lands through willing parties that provide public access to National Forest System lands. Where access needs involving new roads or recreation areas occur within the project area, consider appropriate opportunities for acquisitions of lands or interests of lands. Identify the Forest Plan prescription for these areas and determine whether the opportunity is consistent with Plan direction. Where possible, identify opportunities for road or recreational site development within the "fish, wildlife, and recreation" prescription areas rather than the "backcountry" prescription area.

- Become familiar with the land classifications affecting the remainder of the project area and adjacent lands. Specific documents for consideration include:

  Kenai Area Plan, Alaska Department of Natural Resources, Division of Mining, Land &Water, Resource Assessment & Development Section (2001). [16]

  > This plan discusses the designation of Upper Resurrection Bay and watersheds as an "Area Meriting Special Attention" and includes the drainages of and Salmon Creek. According to the plan, the intent of this designation is "to initiate an interagency planning effort to assist Seward in realizing its community development goals."

  The Seward Highway Scenic Byway Corridor Partnership Plan (1998)

  > This is one of several documents that have resulted from collaborative highway planning efforts. Because of the Forest Service has identified access needs within the project area, participation in highway planning and an improvement effort is critical. Seek opportunities to work with highway planners and engineers to locate turnouts, provide safe crossings for the public and wildlife, protect habitat, plan for trailheads, and provide bicycle lanes and pedestrian paths.
  >
  > Other bodies currently developing plans that may affect lands in the area include the Kenai Peninsula Borough Flood Plan Task Force and the Kenai Mountains-Turnagain Arm National Heritage Area Corridor Communities Association.

- In order to delineate boundaries between National Forest System and other lands in the project area, it may be necessary to survey un-surveyed boundaries.

[16] http://dnr.alaska.gov/mlw/planning/areaplans/kenai/pdfs/master_KAP.pdf

Geology Minerals and Soil

Mineral Development

- Commercial requests for disposal of mineral material sales should be contracted if private resources are not readily available and that free-use requests should be permitted.

Soils

- Begin a Terrestrial mapping program on the Chugach National Forest that ties soils with vegetation and landform together.
- Monitor OHV use across the analysis area. Document their impacts and mitigate as needed. The technology can be relatively low-tech, varying from Come up with a methodology for working on the dispersed camping around Lost Lake.
- Maintain trails using current BMPs. There is a new suite of draft BMPs that should be tested and new monitoring protocols followed (USFS 2011).
- Monitor the Lost Lake area and help guide solutions that minimize further impacts to the soil resource. Examples include but are not limited to, building tent platforms, and designating areas for camping, closing the area to overnight camping.

Hydrology

- Develop a multi-watershed strategy for the Kenai Peninsula to collect baseline data that would be used to evaluate the effects of climate change on various resources, including stream flows and water quality. Monitoring stream temperature is a highly cost-effective way to evaluate the long term impacts of climate change on water resources. Coordinate with other agencies and non-profit groups. Develop a study plan to determine the baseline data needs for evaluating the impacts of climate change.
- Update the National Hydrography Dataset (NHD) and the Watershed Boundary Dataset (WBD) in the analysis area based on recent aerial photography.

Vegetation and Ecology

- Coordination/consultation with wildlife biologists, the State of Alaska, and other wildlife agencies to determine desired species and structures that best meet the needs for wildlife management in the assessment area. This includes identifying locations on non-National Forest lands to accomplish vegetation management projects for species like moose with winter range that occurs mostly on State and private lands.
- Consultation with the State of Alaska and the Kenai Peninsula Borough to accomplish vegetation management in the assessment area due to limited access to National Forest System lands.
- Work with the Chugach Forest Supervisor's office to fund and accomplish vegetation mapping that covers the entire Salmon Creek assessment area with data that is consistent with the Kenai Peninsula Borough Vegetation layer.
- Identify areas to create early-seral hardwoods as directed by the Forest Plan.
- For any vegetation management projects within the assessment area where merchantable wood or fuel wood is produced and accessible, the wood should be utilized.
- Initiate research on effects of climate change in the assessment area to determine changes in vegetation, especially vegetation encroaching on alpine. Coordinate effort with the botany and ecology group.

- Continue to cooperate with State and Private Forestry and Alaska DNR to monitor for exotic pests, such as Asian gypsy moth.
- Complete stocking surveys following vegetation management in order to ensure successful regeneration of harvested areas.

Botany and Weeds

Non-native Plants

- Implement the seven prevention measures listed in the above section.
- Conduct fine-scale inventory of non-native plants in areas of human disturbance in order to plan efficient control projects using integrated weed management techniques. The fine-scale inventory would complement existing inventory and would provide more detailed information on infestations.
- Continue inventory and monitoring to detect new populations of non-native plants. If any new populations are detected, they should be controlled immediately before the infestation becomes well-established. Next to prevention, early detection and rapid response are the most efficient and effective means of control.

Sensitive and Rare Plants

- Conduct systematic surveys for sensitive species in order to determine presence, abundance, and distribution.
- Use new data to help refine and validate the habitat diversity/ bioenvironmental model. In addition, the model can be updated to include the new sensitive species list.
- New data may be used to support a new conservation assessment for a Region 10 sensitive species.

Fire and Fuels

- Determine fuel reduction treatments, where needed, around private lands and within the WUI using a combination of hand and mechanical treatments and prescribed fire applications designed to reduce fuel loadings. Treatments should be sensitive to visual quality and smoke impacts to residents within the analysis area.

- Work with the public to determine if products form fuel reduction efforts are valuable and could be made available.

- Collaborate with the Bear Creek and Seward Volunteer Fire Departments on development of a CWPP (Community Wildfire Protection Plan) for the lands in the Analysis Area included in their service area.

Aquatic Species and Habitats

There are at least five recommendations that are highlighted here in order to facilitate a science-based management of the aquatic resources and habitats within the assessment area. They are as follows:

- With partners work collaboratively to complete an inventory of the aquatic species and associated habitats within the assessment area.
- Pursue the development and implementation of a collaborative approach to monitor aquatic species and habitats for the long-term.
- Assess the potential genetic and ecological impacts of hatchery fish on wild populations and associated aquatic ecosystem.
- Determine if Chinook salmon and Dolly Varden char are in decline.
- Assess the impact of climate change on the status and management of fish and other aquatic resources in the assessment area.
- Design and seek funding for a range of specific research projects that will obtain the information needed to close the aquatic resource data gaps and implement the management strategies described in this report.

Terrestrial Species and Habitats

- Reduce DLP's for black and brown bears in the analysis area near Seward
    - Monitor DLP numbers of brown bears and work with RCBA to increase awareness of using bear proof garbage cans.
- Develop a joint climate change monitoring program with USFWS and NPS to monitor changes in alpine habitats and species as predicted by the USFWS model. If alpine areas start to shrink as predicted, look for ways to reduce stress on alpine species from other sources such as recreation.
- Develop large scale habitat connectivity maps to manage for species migrations and adaptations. Tie habitat linkages from the Salmon Creek watershed to USFWS lands to link habitats on the eastern and western sides of the Peninsula (See Figure 40). Consider this linkage in relation to other planning efforts for habitat linkages at the Russian River Strategic Complex and the Cooper Landing Land Use Classification Plan.

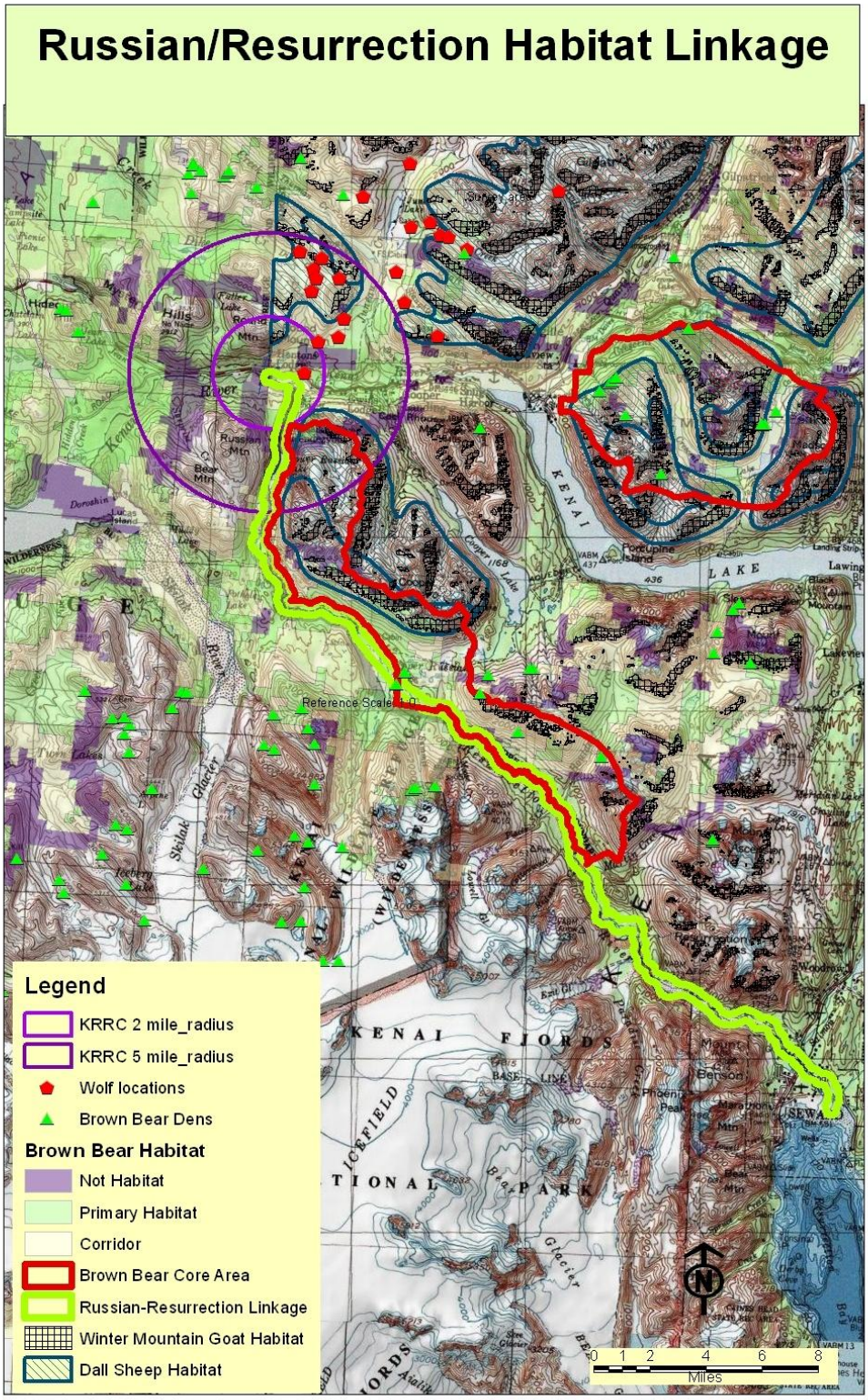


Figure 40. Russian-resurrection Habitat Linkage

Heritage Resources

- Continue to carry out Section 110 surveys outside of the valley bottoms where most project (Section 106) work takes place.
- Establish priorities for assessing National Register eligibility of unevaluated properties in the landscape assessment area.
- Heritage assessment relies upon data which covers less than 0.1% of the landscape assessment area, meaning that actual cultural resource distribution and significance across the landscape assessment area would be different than that defined in this report.
- Take account of high-altitude resources and the impact of climate change on these resources, through survey of high-altitude areas through Section 110 or NFIM survey projects.

Recreation

Manage all recreational use and activities according to Federal laws and the Chugach National Forest Revised Land and Resource Management Plan. Cooperate with the State of Alaska and the Kenai Peninsula Borough on developments within the watershed. Clarify boundaries and authorities. Manage National Forest System lands with an emphasis on non-motorized use during the summer season.

- **Lost Lake Trail** Facility developed for recreational use needs to provide access for people with disabilities. The Forest Service has developed guidelines that describe how to provide this access while also maintaining the setting as described by the ROS (recreational opportunity spectrum). Facilities need to be readily locatable by the public. Adequate sign plans and implementation of these plans is needed to ensure people can find the recreation opportunities we are providing. Develop a summer trail in the vicinity of the winter snow machine trail to wetlands that are being impacted by foot traffic. This will also create a loop trail back to the trailhead from the summer trail.

- **Seward Scenic Byway –** For developments within the Seward Highway Corridor encourage the development to follow guidelines within the Seward Highway Corridor Partnership Plan.

- **Iditarod National Historic Trail –** Continue Trailhead developments at Nash Road and Bear Lake. Coordinate development with the State of Alaska, the Kenai Peninsula Borough and the Iditarod Trailblazers to ensure agreements are in place for these developments. Acquire easements where necessary on Borough Lands in the Little Bear Lake area. Maintain and improve the trail system with assistance of the Seward Iditarod Trailblazers.

- **Other Trail Developments -** Work with the Borough and the State Agencies to develop a plan for managing Grouse Lake. Incorporate into that plan a potential trailhead sight for the Old Lost Creek Trail off of the Grouse Lake Road. Once a trailhead site is secured develop this trail into a non-motorized winter access. Monitor resource damage on the Tiehack & Mount Alice user trails.

- **Visitor Use -** Develop a visitor use study to better understand public use. Include in the study the types of recreational use and where it occurs within the watershed. Monitor use to ensure that impacts to resources are avoided or minimized and assure that the

recreation experience remains positive. Develop management strategies to decrease use conflicts between different user groups.

- **Monitoring –** Monitor all recreation use in the watershed. Develop a plan for managing campsites around Lost Lake. Maintaining a diversity of recreational opportunities and experiences in the watershed is recommended to better meet the needs of a diverse public, i.e., providing low use, solitude experiences on the east side mountains.

Joint Recommendations

The following joint recommendations, data gaps and monitoring needs were identified by the group:

Lost Lake- Recreation Monitoring

- Develop a cooperative monitoring program with recreation, wildlife, soils that will identify summer and winter recreation use levels at Lost Lake, impacts to soils and wildlife and habitat. Monitor levels and areas of OHV use (particularly in regard to mountain goat habitat). The plan should identify threshold levels of interactions to trigger management action.
-

Climate Change Monitoring

- Develop a joint climate change monitoring program with USFWS and NPS to monitor changes in alpine habitats and species as predicted by the USFWS model.
- Develop large scale habitat connectivity maps to manage for species migrations and adaptations.
- Develop a multi-watershed strategy for the Kenai Peninsula to collect baseline data that would be used to evaluate the effects of climate change on various resources, including stream flows and water quality. Monitoring stream temperature is a highly cost-effective way to evaluate the long term impacts of climate change on water resources. Coordinate with other agencies and non-profit groups. Develop a study plan to determine the baseline data needs for evaluating the impacts of climate change.
- Take account of high-altitude heritage resources and the impact of climate change on these resources, through survey of high-altitude areas through Section 110 or NFIM survey projects.

Terrestrial Ecosystem Mapping Program

- Begin a Terrestrial mapping program on the Chugach National Forest that ties soils with vegetation, landform, and wildlife habitat and wildlife species together. Tie it to information on suitable uses.

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